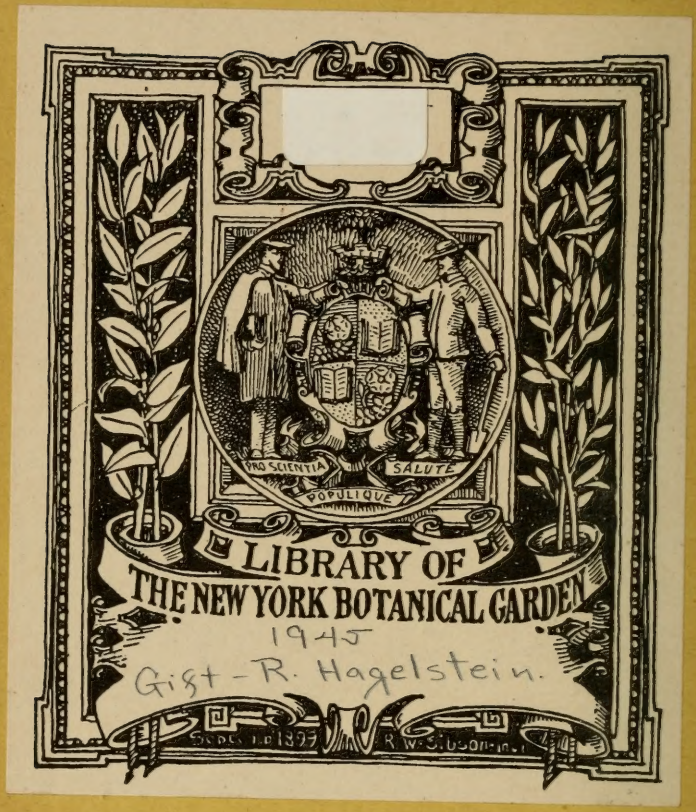
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THE MICROSCOPE.

AN

ILLUSTRATED MONTHLY MAGAZINE

—FOR THE—

Student of Nature's Little Things.

—EDITED BY—

DR. ALFRED C. STOKES.

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THE MICROSCOPE

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ORIGINAL COMMUNICATIONS

THE COLORLESS CELLS OF THE BLOOD.

GEORGE A. PIERSOL, M. D.,

PROFESSOR OF HISTOLOGY AND EMBRYOLOGY IN THE UNIVERSITY OF PENNSYLVANIA.

THE little nucleated naked and colorless masses of active protoplasm observed among the colored cells in the blood are elements having a very wide distribution, being constant among the vertebrates, and occurring in the circulating fluid in many of the lower animals.

The colorless or "white" blood corpuscles represent the type of the embryonal cell, and exhibit in a high degree the characteristics of free, active, formative protoplasm, such as in the early stages of the animal constituted its greater part. In common with all other free masses of active protoplasm, these cells continually exhibit marked alterations in form, and since such changes closely resemble those observed in that simple animal, the *Amœba*, they were, naturally enough, termed "amœboid," and while, of course, not identical, the *Amœba* and the colorless blood cell both possess this characteristic of active protoplasm, the substance of which both are formed.

The single cell of the *Amœba* constitutes the entire individual, leading an independent existence, and ministering only to its individual needs; the colorless blood corpuscle, on the contrary, is but one of a great community of cells, each member of which, while primarily concerned in its own necessities, is engaged in the maintenance and promotion of the general wealth of the entire organism.

The structure of the protoplasm of these elements is a subject which has attracted much attention and elicited bitter discussion. As usual, the truth lies midway between the extremes of the conflicting opinions. It is now well established, and generally accepted, that the living protoplasm of active cells, as the colorless blood corpuscles, is composed of two parts: the active, contractile, albuminous bioplasm, and the relatively inert paraplasm; upon the arrangement of these two constituents of the cell does the appearance of its protoplasm depend. Where both bioplasm and paraplasm occur as closely intermingled particles a finely granular appearance results; where the protoplasm is heaped up together, dividing the protoplasm into bands and septa, a more or less perfect network or reticulum is formed. An important fact to be appreciated in this connection is, that the arrangement of the constituents of protoplasm is not constant, but subject to continual change, a truth that every one who has carefully studied the white blood cell under high powers must admit; in such elements, the formation, transient presence, and disappearance of networks are continually occurring, demonstrating the inaccuracy of describing temporary conditions as the constant structure of protoplasm. In cells more highly specialized than the colorless blood corpuscle, especially in those where particles of secretion are often stored, as in the glandular epithelium, a reticulated condition of the protoplasm is very marked; the bioplasm is pushed aside by the inert substances, the entire cell assuming a sponge-like arrangement, in which the framework is formed by the active contractile substance, while the passive materials fill the interspaces.

The reproduction of the white blood cell is of interest, as affording one of the gradually decreasing group for which the direct mode of division is still recognized. That division in the simplest manner does here take place seems to admit of little doubt, but, on the other hand, it is highly probable that the in-

direct mode, accompanied by complicated nuclear changes, or karyomitosis, may also be followed in the division of some, at least, of these cells.

Studied as they so usually are, as elements of the blood, we too often forget their true nature, and regard them as peculiar to this fluid. Originating in the various accumulations of adenoid tissue throughout the body, the lymphatic glands, they form the "lymphoid cells;" passing into, and circulating through, the lymphatic vessels, they are the "lymph corpuscles;" on being poured into the venous stream, they become the "white" cells of the blood, the "leucocytes;" passing beyond the limits of the blood and lymph channels into various structures, they constitute the "wandering cells" of connective and of other tissues; in the marrow, they are the "marrow cells;" in short, we have to deal with a widely distributed element, whose names are as various as the locations in which it is encountered, but which names all refer to one and the same morphological element.

The genetic relation between the colorless and the colored cells of the blood, the white being regarded as the progenitors of the red, yearly becomes more doubtful, while the estimation of the colorless cells as independent elements, having but slight direct relation with the red, gains ground, being more in accord with the broader views taught by recent investigations. The colorless cells of the blood are to be considered, not as younger or immature forms of the red corpuscles, but as circulating masses of reserved formative protoplasm, the direct descendants or representatives of the great energetic mesoblastic tract; these particles—"Protoblasts" [Kölliker], they may be called—play a double role, removing broken down and effete matters, and repairing destructive processes by supplying material for new tissues. The white blood cells are the sanitary police of the economy, even mingling with the crowds that throng that great highway of exchange, the blood, to take up and remove offensive and injurious debris, to suppress the undesirable presence of degenerate members of the community of cells, even to the arrest and imprisonment of obnioxous intruding microbes; nor are these faithful patrolmen content to limit their vigils to the frequented thoroughfares, but they pass out into the tortuous byways and narrow lanes of the tissues themselves, penetrating into the remotest nooks and darkest corners of the lymphatic clefts

in the performance of their duty; on the other hand, they guard with jealous zeal the integrity of their domain; should structural injury occur to any part, they are easily on the guard to resist destructive processes and to furnish active aid in instituting repairs.

A USEFUL MOUNTING MENSTRUUM.

DR ALFRED C. STOKES.

IN a recent number of *Malpighia*, M. Aser Poli called attention to the oil of cajeput as a valuable medium in which to place objects before their permanent mounting in Canada balsam, it being used as a clearing agent instead of the oil of cloves. He states that it is soluble in dilute alcohol and thus permits of the direct transfer of the object to it, thereby avoiding the use of absolute alcohol. He also remarks that trials with the oil have been followed by beautiful results, the preparations being perfectly clear, and that delicate objects such as the marine Algæ, which are among the most difficult to preserve in a satisfactory way, are, when treated with the oil of cajeput, almost entirely free from the ordinary obnoxious shrinkage.

These qualities are all excellent ones, and by the microscopist that does but little work in mounting, the chance to simplify the operation should be hailed with joy. To do away with one of the processes that modern methods seem to consider necessary will be a boon. By the use of the oil of cajeput the worker can simplify his methods by discarding the absolute alcohol, and thus not only save himself considerable trouble and some time, but some expense, as an object cleared, or soaked in oil of cloves, can not well be transferred from it to balsam without the intervention of absolute alcohol.

After having been cleared, or soaked, in the cajeput oil, the object may at once be mounted in the ordinary balsam or in that dissolved in benzol or in chloroform. It is this character that gives the oil its chief value. Absolute alcohol must be kept in a specially prepared bottle, as it evaporates rapidly and absorbs water greedily. To avoid its use is pleasant indeed.

Since reading M. Poli's account of the action of the oil I have been making a few experiments, and refer to them here in the hope that some that in their microscopical work have more need

of mounting than I, will take up the subject, continue the experiments and report the results.

In my limited experience I have been pleased with the oil. It has a pleasantly aromatic odor, and a pale green color that is in no way objectionable. Placed on a glass slip it evaporates, but not with such haste that the microscopist must hurry his movements to do as he would, before it is gone; it evaporates somewhat slowly and leaves no trace on the glass. It is soluble in carbolic acid, or the commercial liquid acid as obtained of the druggist, is soluble in it. With old benzol balsam that had become so hard and so nearly dry in the bottle that it had to be dug out with a knife in a stringy mass, the oil mixed perfectly, making the old material fluid and easily worked. What its action would be with benzol itself I can only infer from this experiment. In dilute alcohol it is, as Monsieur Poli has said, perfectly soluble.

After evaporating Canada balsam to glassy hardness in the ordinary way before dissolving it in benzol or in chloroform, I dissolved it in the oil of cajeput, to learn what would be the result. This I found to be excellent. The hard balsam dissolves readily in the oil, and makes as thick or as thin a fluid as may be wanted. The solution, however, although readily effected, appears to take place with rather less facility than with benzol or chloroform. Still, it is accomplished by leaving the mixture to itself, the solution being made without attention on the part of the microscopist.

The results of mounting in the cajeput balsam justify all the good words that M. Poli has spoken of the oil as a clearing medium. After the object has been soaked in dilute alcohol for a convenient time, it is transferred to the oil of cajeput for as long as the microscopist may wish, and thence to the cajeput balsam in which it is to be mounted. Under the cover glass drying seems to be as rapid as with benzol balsam; the little that is unavoidably spread on the slip appears, however, to harden rather more slowly, yet I have made no comparative test. The effects of the mounting medium are excellent; as far as I can perceive, quite as good as those from benzol or chloroform balsam; and the simplifying of the process should be greatly in its favor with those that are not professional preparers and are therefore not ready to give any amount of time and attention to their special work.

I have not tried it with staining fluids. This I must leave to others. M. Poli, however, in the note already referred to, says that objects treated with it, stained green and then mounted in Canada balsam retain their color. Further than that nothing is known about this part of the subject.

The reader will perceive that my experiments have been few and of little importance. I mention the matter only because I believe the menstruum will prove to be an exceedingly useful one, especially to the amateur, to whom the simplifying of the process, and the avoidance of the use of absolute alcohol should certainly make it acceptable. The suggestion is not original with M. Poli, as the oil has been used by others and referred to in print, but has never come into general use, as it should.

I wish Dr Thomas Taylor, of the Department of Agriculture, Dr F. L. James, Prof H. M. Whelpley, Miss M. A. Booth, and other expert preparers of microscopic objects would experiment with the oil, and report their results for the benefit of us that do less in that way than they. I suggest the subject and leave it with the reader, feeling sure that the use of the oil is to be commended.

PROFESSOR KOCH AND HIS DISCOVERIES[1].

DR CHARLES HACKS.

"My hour of consultation is between 12 and 1 o'clock," signed "Koch." This is written on a little square piece of paper fastened by four pins in a gray frame against the wall at the foot of the grand staircase in the entrance of the Imperial Hygienic Institute, in Berlin, and it was this that four European reporters were studying on the 5th of November, at 9 o'clock in the morning. Alas! what an illusion! Many others have been stopped by that little card, and gone no further. It is not easy, in fact, to reach this celebrated savant. From the porter to the secretaries, every one is extremely reserved in that house. It is almost impossible not to have one's card intercepted before it reaches its destination. We had the good fortune, nevertheless, to overcome all obstacles, and by exceptional favor obtained admission.

. . . . . .

Dr Koch was born December 11, 1843, at Clausthal, where

1 L' Illustration. Cf. Scientific American.

he first attended school. From 1862 to 1866 he studied medicine at Goettingen; then, having become a professor of medicine, he commenced his practice at Posen.

A few years later he was chosen professor and commenced his first work on the study of tuberculosis. He discovered the bacilli, he studied them, and settled the fact that consumption

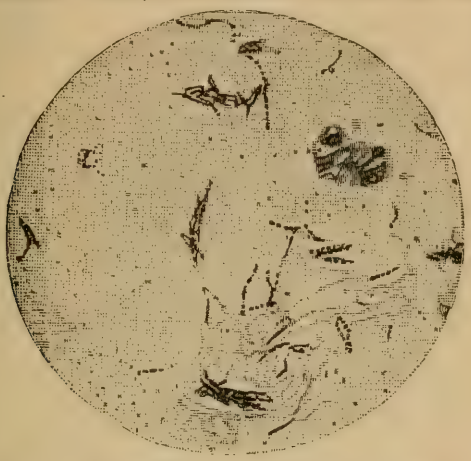


FIG. 1.—The bacilli of consumption from fresh mucus examined under the microscope.

is caused by them. This work at once put him in the very first rank, so that in 1883 he was sent by the Prussian government to India to make a study of cholera and to discover the cause of that infectious malady. This time again success crowned his efforts, and it is admitted to-day without doubt that cholera is caused by comma bacilli (a name which Dr Koch himself gave them on account of their resemblance to the comma), as tuberculosis is caused by the Koch bacilli. As a reward for his services, on his return the State voted him a purse of $25,000. The importance of the work of this German savant was thus recognized, and it appears that he was justly entitled to be considered one of the most extraordinary persons of our time. It may be well to mention at this point that according to Koch there is no fear of cholera returning to Europe, or at least it will not pass beyond some of the countries of the south. Berlin with its remarkable system of sewerage, and Paris also, have nothing to fear from that terrible malady. This is certainly reassuring. Thus it may be seen that the object of all of Professor Koch's work is

the discovery of the cause of infectious diseases. He is satisfied that what he has done for tuberculosis and cholera, and what others have accomplished for other maladies that are less deadly, such as erysipelas, could also be done for all diseases, whatever they may be. From this it may be seen that his labor on behalf of science is not yet finished. It appears in fact that Koch has for the time being abandoned the examination of microbes for a study of their destruction in the living human body.

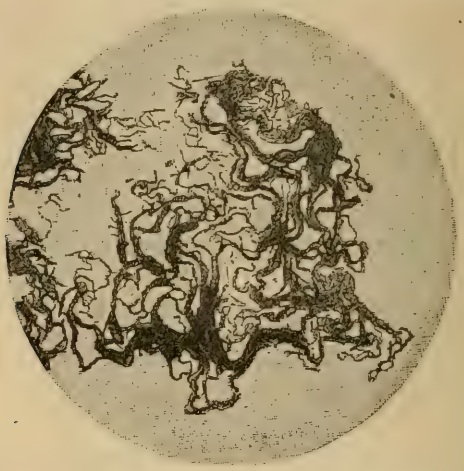


FIG. 2.—The same bacilli examined under the microscope after fourteen days' development.

Prof Koch first commenced experiments with a tube here represented. It is an ordinary test tube, such as is used in all ordinary experiments. It is, in the first place, sterilized over the fire, then a bouilon of sterilized culture is poured into it, that is to say, culture which does not contain any germ. This bouillon is prepared with agar-agar, a sort of gelatine. When this had been done the microbe, which is taken directly from the mucus of a consumptive, is placed in the tube and the orifice closed with cotton, thereby permitting the air to pass into the the vessel, but retaining the organisms which are held suspended therein. The tube thus prepared is subjected to an even temperature in an oven. After a certain length of time the microbes begin to develop and increase, and assume the clotted appearance which we see in Fig. 3 of the engravings. But in

FIG. 3.—A part of a culture tube containing the germs of bacilli of tuberculosis from Dr Koch's laboratory.

order to experiment effectually it is necessary to have the culture absolutely pure, and it is obtained in this manner: In the first place take some of that treated as above and place it in another tube. This is repeated; after 50 or 60 successive changes of this nature a residuum is obtained which is called pure culture, that is to say, it contains absolutely nothing but the microbe which it is desired to study. The pure culture of bacilli of tuberculosis is represented in the photograph which we have reproduced, Fig. 4, the negative of which came from the Koch laboratory. It gives perfectly the idea of what may be seen in the field of the microscope. Each one of the black lines seen in the photograph represents a bacillus, that is, a pathogenic organism, which is the cause of the disease and which was discovered by Koch. It was upon these pure cultures that Koch made his first experiments, to try upon each one a long series of chemical reagents, of which the following are the principal: In the series of ethers, etherized oil; of the series of aromatics, *B* naphthaline, paratoluidine, xylidine, fuchsine; among the colors, gentian violet, methylene blue, China yellow, anilin yellow, orimene; of metals, tin, silver, and gold. He found the action of the last of these the most energetic of all.

It only required one or two millionths of chloro-cyanide of gold to stop all development of bacilli of tuberculosis in pure culture. It is seen what an enormous amount of time and trouble was required to make all these tests. Koch saw not only that all the substances which we have cited, but many others with which he experimented—a list of which would be too long to give here—have the power in a test tube of arresting the development of bacilli of consumption. He had, therefore, finished the first part of his programme in searching for the substances which when mixed with pure culture of bacilli of tuberculosis were able to arrest their development. He passed on then to the second part of the programme, viz., experiments

upon animals. He selected the guinea pig as a subject, because of all animals this is the most liable to tuberculosis when inoculated. He tried all the substances mentioned in the foregoing list upon the guinea pigs thus rendered consumptive, and he observed that although the action of these substances was so remarkable in the test tube, there was no apparant result when they were applied to the animal. All the inoculated guinea pigs died of consumption. Without being discouraged, however, he undertook a second series of experiments, also upon living animals. He succeeded in discovering a substance (and it is here that the secret begins) which, active in the test tube, preserves its action when it is transferred to the body of the animal. Upon the second series of guinea pigs which have been inoculated, the increase of the bacilli was stopped as soon as the substance was administered, and all were cured. Here it is necessary to rectify an error which the journals have spread. It is known that he made his experiments upon a large number of animals, and every day one of this number disappeared, and it was supposed that it was one of those that had been inoculated. No, it was simply that he killed one from day to day because he wished to follow all the stages that were reached. In all the autopsies it was found that the lesion was stopped as soon as the substance was injected, no matter what stage of development the disease had reached. He was, therefore, able to let a number of ex-consumptives live, and they are to-day in a perfect state of health.

It was after these two series of investigations, which were so long, that have arrived at a definite result, he was enabled, before the Congress of Physicians held in Berlin in August last, to make his first communication, which caused so remarkable a sensation. This is what he said in concluding his remarks: "My researches are not yet entirely finished, and I am only able to affirm one thing, viz., that the guinea pig, which is, as every one knows, liable to consumption, becomes entirely free from it the moment that it has absorbed the substance, and from that moment the disease is arrested and its progress stopped, whatever may have been the stage previously reached, and that also without the constitution being in any way impaired. I am only able to draw one conclusion from these researches, viz., the possibilities which exist from this day of paralyzing absolutely

the action of the microbes in the animal. It is a new field open to experiment and observation." These were exactly, word for word, the conclusions of Dr Koch in the month of August last, and it is on a false interpretation, or rather on a premature conclusion, that the idea was created at that time that his researches had attained to the cure of consumption in the case of man. Dr Koch had not even made allusions to this. It was only later, and following always the idea and the scientific methods which have always guided Dr Koch, that he began to experiment upon man, guided by the definite results already obtained upon animals and with a feeling of certainty that like results would follow.

With a simple Pravaz syringe and drops of the liquid, the consumption disappears and the hectic flush is modified; the patient is cured; and if Dr Koch is not yet willing to divulge his secret it is because he is wise in his own opinion, founded on scientific principles, and that he is not willing to leave one iota

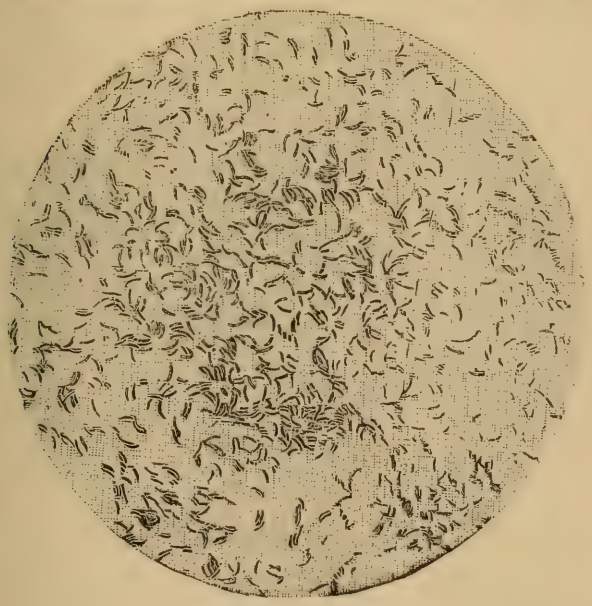


FIG. 4.—A pure culture of the bacilli of tuberculosis examined under the microscope.

of error. He was able to kill and to examine his guinea pigs when he wished to know the degree of advance in their cure; but he can-

not follow the same course with men. He is no longer experimenting, he is curing. He is obliged to wait until his cure is complete and absolute. When the last of his patients is a well man, he will speak, and we shall know all. Before then he will say nothing. This is the cause of his delay in satisfying a public curious and anxious to know all. These are the sorts of discoveries that open up the infinite horizons of science and elevate to the highest pinnacle the one who has conducted the experiments; and one is compelled to respect the true savant, who fears notoriety, and who will quietly and modestly bestow, some day, this cure upon humanity, without any recompense (in spite of offers of all kinds, which come to him from every side), without any other profit than adding one more leaf to the already beautiful crown of that modern science of which the French genius, in the person of the great Pasteur, has furnished the elements, founded the principles, and brought about such magnificent results.

REFERENCE TABLES FOR MICROSCOPICAL WORK.

COMPILED BY PROF A. B. AUBERT.

II.

PRESERVATIVE AND MOUNTING MEDIA.

GUM WITH CHLORAL HYDRATE: gum Arabic, chloral hydrate, water. A cylinder 60c.c. contents is filled $\frac{2}{3}$ with gum Arabic in pieces; to this is added a solution of chloral hydrate (several per cent.) containing 5—10 per cent. of glycerine; shake often; in a few days the gum will dissolve; the syrupy liquid is filtered. Carmine and hæmatoxylin stained objects can be mounted in this medium.

GUM AND ACETATE OF POTASH or of ammonia: gum Arabic, acetate of potash or of ammonia, glycerine, water. Made as the preceding medium, only a solution of potassic or ammonic acetate is used instead of a solution of chloral. Anilin stained objects can be mounted in this.

IODIZED SERUM, artificial (Ranvier): 1, distilled water, 135 grms.; 2, egg albumen, 15 grms.; 3, common salt, 0.2 grms.; 4, tincture of iodine, 3 grms. Mix 1, 2 and 3, and filter; add 4, and filter again. Used for examinations, not for mounting.

POTASSIO-MUCURIC IODIDE (Stephenson): biniodide of mercury, iodide of potassium, water. To the water add an excess of each

salt, and filter. This gives a very dense liquid of high refractive index (3.02). For Diatoms, etc.; may be used diluted.

Monobromide of naphthalin. High refractive index; for Diatoms, etc.

Monobromide balsam: solution of hardened Canada balsam in monobromide of naphthalin. Refractive index high, 1.6; shows finer structure of Diatoms, etc.

Monobromide tolu. Weir's medium: solution of balsam tolu in monobromide of naphthalin. Refractive index 1.73; may prove very valuable as a medium for Diatoms. *Preparation.* Dissolve 3 ounces of balsam tolu in 4 fluid drams of benzol, add 4 fluid ounces carbon disulpide, shake well; let separate into layers; pour off carbon disulphide; renew this treatment with more carbon disulphide; pour it off again; evaporate the benzol from the balsam tolu. The tolu will now be free from cinnamic acid; put 1 fluid dram of monobromide of naphthalin in ½ ounce vial, add enough of the purified tolu to make a stiff mixture or solution when cold. Heat to 104° or 122° F. when using.

Pacini's solution: sodium chloride, 1 part; corrosive sublimate, 2 parts; water 113 parts; glycerine, 13 parts. Let it stand 3 months, then use 1 part with 3 of water; filter before using. Recommended as a preservative of delicate tissues.

Phosphorus (Stephenson): concentrated solution in carbon disulphide. High refractive index; difficult and dangerous to use; takes fire spontaneously in the air.

Ripart's solution: camphor water, 75 parts; distilled water, 75 parts; glacial acetic acid, 1 part; copper acetate, 0.3 parts; copper chloride, 0.3 parts. Useful for delicate vegetable tissues, Desmids, Confervæ, etc.

Styrax: chloroform solution For Diatoms; high refractive index.

American styrax: chloroform solution filtered and hardened. Color as light as that of good balsam; high refractive index; for Diatoms and fine tissues.

Harting's corrosive sublimate solution: corrosive sublimate, 1 part; water 200 to 500 parts. For blood corpuscles, etc.

William's solution: saltpetre, 2 ounces; sal ammoniac, 2 drams; corrosive sublimate, 1 dram; glycerine, 2 ounces; alcohol, 1 pint; water 2 quarts. Let stand for several days; filter.

More properly a preservative for large anatomical and other specimens.

WICKERSHEIM'S SOLUTION: alum, 100 grms.; saltpetre, 12 grms.; potash, 60 grms.; arsenious oxide, 20 grms.; boiled water, 3000 grms. A preservative of large anatomical and other specimens.

VIRODTZEFF'S SOLUTION: glycerine, 2160 parts; water 1080 parts; alcohol, 45 parts; thymol, 5 parts. A preservative of large anatomical and other specimens.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XIV.

THE SELECTION OF A STAND.

THE size is less important than the weight, provided the space about the stage is not limited. It is exceedingly inconvenient and annoying to be forced carefully to insert a thumb and a finger between the stage and the arm, while the other three fingers are coiled into a knot or extended rigidly into the atmosphere. Every time the owner of such a stand attaches an objective to it, not only will his three fingers become rigid, but his left arm and both legs, and finally his whole body will be sympathetically tetanized.

In the smaller stands the sub-stage space is also too limited. No room is left for certain substage accessories which the microscopist will surely want if he is to be anything more than a mere gazer at pretty objects. Such instruments seldom have more under the stage than a shallow box whose upper or lower surface carries the diaphragm plate.

There is no provision for a condenser, polariscope or any other accessory, and therein they are defective.

Personally, therefore, I prefer a large stand. It always has plenty of weight, solidity and steadiness, with abundant space for finger manipulations. The faults mentioned in connection with small stands are due solely to the carelessness or the ignorance of their makers, since few manufacturers are practical, working microscopists.

I would never give the beginner an inferior optical outfit, if his purpose were a serious one. He should have the best and

the most complete that the means at my disposal would allow. It is not advisable to contract bad microscopical habits by using a cheap and almost worthless stand with French Triplets, or to acquire erroneous ideas of appearance and structure by the use of such instruments, only to be forced again to travel over the same road to correct improper methods and to unlearn erroneous notions. The beginner should be started aright at the beginning. There is in microscopy a straight and narrow path leading to the light, as there is elsewhere; and there is a broad and easy road that leads to microscopical destruction. I would not have the reader enter on the latter. To avoid it he should seek the best of everything microscopical within his reach. The learned editor of the *Journal of the Royal Microscopical Society* has expressed the same teaching in the following words: "It appears to us regrettable that so many opticians should struggle to issue 'Students' microscopes, the chief aim of which appears to be low cost of production regardless of the modern requirements in such instruments. Our own experience is that with a stand well equipped with substage appliances for controlling the illumination, every good objective may be made to yield images at least fifty per cent. better than are possible without such appliances. A 'student' should obviously commence his training in microscopy by learning to use his optical battery in the most effective manner, which practically necessitates his being provided with a stand altogether superior in construction to those usually supplied as 'students' microscopes."

But when about to select a stand the beginner should first decide what he wants to do with it. This I have repeated and reiterated, and I do so because of its great importance. A small foreign stand made on the continental model,or a small American stand with a divided body tube and no substage provisions for optical development, will not be usable for all purposes, as a large and complete American stand will be. For the study of the innumerable common objects mountable by the student himself, the small low stand is sufficient; and these objects are valuable, instructive and commendable in many ways, but I suppose that the beginner will desire to become an investigator, after he has had some experience as a looker on when pretty things are exhibited. Complex and complete stands may be used for attractive specimens, and for investigations as well.

It has been said that the short body and the vertical position are essential to the proper study of Histology and Embryology. I do not believe it. The reason offered is that the objects must frequently be examined in liquid and before their preparation is complete, in which case the stage must be horizontal to prevent the liquid from running away. A histological laboratory must be a sloppy and an unattractive place. I had supposed that the use of the microscope was conducive to neatness and care, demanding unusual tidiness and cleanliness in the preparation of objects. Of course, if the stage is inclined and a large amount of liquid is around the uncovered specimen, the fluid will run, and drip, and make the stand unsightly to the fastidious student. But the vertical position of the short-bodied stand is not conducive to a clear brain; it is conducive to a congested one. Consequently, if the reader wants that, and also wants the object so roughly and carelessly and incompletely prepared, he will buy a German or a French stand. If he wants to be an investigator and to go about the work as his idiosyncrasies may prompt him, he will think long and seriously before he selects one of these continental models. Such a stand will cost more than a better grade among the cheapest American instruments, but it will have a horse-shoe shaped base to keep away the witches. If he is afraid of the witches he would do well to get such a stand. Otherwise not.

Naegeli and Schwendener, in their work on the *Microscope in Theory and Practice*, speak of the inclination of the body tube, and tell us how the instrument may be placed in a horizontal position when the stand has no joint at the top of the pillar. "Large stands," they say, "are sometimes arranged so that the body-tube turns with the object-stage on a horizontal axis, and may, therefore, be inclined at any desired angle; a more convenient position of the head is thus attained, and the body-tube may be used in a horizontal position. These advantages, however, seem to us to be more than counterbalanced by the inconvenience which the inclination of the stage involves. Where a horizontal position of the body-tube is required, which is seldom the case, the instrument may be laid down. The horse-shoe stands are excellently adapted for this purpose, the two ends of the horse-shoe forming, with the stage, a heavy tripod."

"The instrument may be laid down." Those American microscopists that beg their pupils to use no other than German stands, do they teach those unfortunate pupils the proper method of "laying down" the stand? It is to be hoped so. To "lay down the stand" and to do it properly, must be the very acme of microscopical accomplishments. But what then becomes of the microscopist? Does he grovel on his stomach, and rear his head like a mud-turtle? "The horse-shoe stands are excellently adapted for this purpose, the two ends of the horse-shoe forming, with the stage, a heavy tripod." The reader will find these amazing sentences on page 121 of the English translation of the German work referred to. They explain the object of the horse-shoe shaped base of the German stands, a matter it seems, that I did not before appreciate.

A well known microscopist, who scarcely conceals himself behind the transparent disguise of "J. G. H.", describing in *The Microscopical Bulletin*, a desirable instrument for the student, says: "The base is large enough for steadiness, and rests on *three* toes, a feature generally absent in German microscopes of this class. The large, *thin* glass stage, always essential where liquids are used, two and a half inches by four, stands, when horizontal, three and a quarter inches from the table, and is movable by the fingers in every direction. No clips disfigure the stage ready to scalp off the cover glass when the slide is freely moved, as in many essential observations. The microscope *inclines* to any angle on a properly made trunnion, a *positive requisite* in all microscopes, enabling thereby important observations to be easily made, which cannot be done when the stage is restricted to the horizontal. I have not found this *inclined glass* stage incompatible with the use of fluids, and every instrument *should have this facility* when needed. . . .Coarse adjustment for focus is by rack and pinion, mechanically perfect, and the fine adjustment is without the *slightest lateral* twist, and moves the entire optical part above the stage. This cannot be said of this class of microscopes of European make. A movable substage, accurately centred for necessary illuminating apparatus, and a concave and plain mirror, also movable or stationary as necessity may require. This substage holds the Iris diaphragm and achromatic condenser, without which no instrument works at its *best* capacity. The lenses are equal to anything European of like

grade, and I have had some experience in this matter. The workmanship of this student microscope is unexcelled by anything made elsewhere and unequalled by any German instrument I have ever seen. Yet this microscope is altogether American; and there are a hundred such in use by others than 'amateur collectors' within my microscopical horizon. . .If we turn now to the highest class of microscopes, such as the expert purchases for his own use, the best of German and French make are but candle-sticks compared to the American or English.

"After all everything doesn't depend on the microscope. The brain behind it is an important factor. Already our best makers give us instruments too good for the execrable microscopical work done in some university and college laboratories. A large part of it has no real educational value for the student, and happy should he be if he escape the dogmatism of his demonstrator, or see with positive clearness *one* preparation retaining all the delicate morphological elements Nature puts in it."

This is admirable doctrine preached in an incisive and admirable way. In the quotation I have taken no liberties with the author's italics. The stand that he describes is evidently one of Mr Zentmayer's superb instruments, probably the Histological.

CAN MOUNTING MEDIA BE IMPROVED FOR HIGH POWERS BY INCREASING THE INDEX OF REFRACTION?

J. D. BECK.

IT has been the aim of the microscopist to increase the refractive power of mounting media for Diatoms, bacteria, biological and other specimens requiring a high amplification and the best resolution. Whether better results are attainable in this direction I am unable to say. All my Diatoms, slides from J. D. Möller, et al., are mounted dry or in balsam; I have never tried Prof Smith's medium. If the increase in refraction is an improvement, would it not be a desideratum to attain still more satifactory results, which perhaps might be accomplished by increasing the index of refraction of mounting media? The desideratum is to see what exists, and to secure for that the most favorable means, bearing in mind that we must not expect too much from the best lenses under unfavorable conditions or cir-

cumstances. A certain quack condemned my Beck's $\frac{1}{6}$ inch objective because with it and a Beck's No. 2 ocular he could not see bacteria in spring water, when in fact the water, which was as cold as ice, came out of a mountain of rocks so free of vegetable and organic matter that no organisms could live in it, while a drop of water from a rivulet showed thousands of bacteria under the same lens.

Inasmuch as a large majority of microscopists cannot afford to buy the new Zeiss apochromatic objectives, they may perhaps increase the resolving or defining powers of their lenses of a cheap grade by improving the refractive properties of mounting media. While the philosophy of the Irishman, "That if a little is good, more is better," when he imbibed the second glass, may be rather extravagant in such cases, yet it may be solid philosophy for practical purposes in other directions; so then may we not continue to experiment on media to increase the refractive power until we find still more satisfactory results?

A friend of mine copied and sent me a list from a table of refractive indices. The highest index of fifty substances given is that of chromate of lead at 2.50 to 2.97. It would appear that all the salts of lead and zinc have a high index of refraction, which seems to be very much increased by the action of the chromic acid which probably exists in the metal chromium in a higher degree than in lead or zinc. I do not believe that nitre, which combines with chromium to form chromate of potassium, afterwards changed to bi-chromate of potassium through the action of sulphuric acid when exposed to acetate of lead, really increases the refraction of chromate of lead. I have my doubts whether the acetate of lead adds any refractive power to the bi-chromate of potassium. Native sulphur is given at 2.115, but when distilled with charcoal and reduced to a volatile spirit by adding one atom of carbon to two atoms of sulphur, forming bi-sulphide of carbon, the index is reduced from 2.115 to 1.678. This is what the carbon has done, and yet diamond, which is carbon crystallized, is way up to 2.47 to 2.75. I suppose it would be impossible to bleach and to reduce the chromate of lead to a colorless medium without destroying its high refraction. We might expose colorless linseed oil to the action of chromate of lead by heat, and when well settled filter a number of times or clarify it as varnish is clarified. This would become a rapid

drying medium *per se*. Resins might be treated with chromate of lead in the same manner. Whether this suggestion is practical, I will leave for others to decide who have more experience and skill in chemistry than I.

What can be done with sulphur and phosphorus? Can we dissolve sulphur in oil and make a transparent medium of it?

There are phosphorus, 2.224; carbonate of lead, 1.866; oil of anise seed, 1.111; bi-sulphate of carbon, 1.678; all pretty high; what can be done with them? There may be other substances higher and better than those mentioned. How many will act in this important matter?

LEAVES FROM A MICROSCOPICAL NOTE-BOOK.

GRAYBEARD.

I.

MORE than a half-century ago I had a compound microscope made by Benjamin Pike, Sr., of New York, placed in my hands, and from that time to date it has been a constant microscopical evolution with me—a survival of the fittest.

If there is any one grand mystery involved in the manipulation of the instrumeut my experience would assert that it is to be found in the handling of the mirror. Like many others, I have had my full share of attacks from the accessory fever, each new purchase, in the main, being laid aside to study more thoroughly the effects obtained alone by the mirror—the master agent of manipulative skill.

My stand-by for work is George Wale's little stand with its accurately ground plane and concave mirrors, "Greybeard's diaphragm lamp" (see Elmira meeting of A. S. M.), and an occasional bull's eye brought into play over such tests as *Amphipleura pellucida*. As to objectives, my preference is for wider angles of aperture, dry adjustable ones from $\frac{1}{10}$ up to $\frac{1}{6}$. One-sixth and higher, homogeneous immersion of the highest grade of workmanship, aye, more, of art inspiration in its corrections, and adjustable in every instance.

"When I get old what effect will the use of the microscope have upon my sight?" I can only answer this by saying that in my case I can sit for from four to six hours over the tube, night after night and not fatigue my eyes; but let me advise those younger than the writer to avoid any verging to a dazzling

flood of light, for it not only blurs out detail but will force you to abandon the microscope long before you become old.

It must not be inferred that I make a wholesale condemnation of modern accessories, for many of them at times, for special work, become valuable adjuncts to the microscope. The Iris diaphragm is emphatically endorsed by the human eye; Nature often gives us the hint for improvement, if we would only follow her teachings. A first class, wide angle substage condenser, dry and immersion, does good work when properly used under test objects and expert research, yet as a constant adjunct to the microscope, as many seem to use it, my experience condemns it in favor of the mirror alone.

If the young microscopist has a fat bank account I see no objection to his making a complete museum of his den for the exhibit of microscopical accessories; yet the student of limited means need not feel discouraged by the absence of these. A well made, low priced stand, a few first class objectives, a bull's eye and a flat wick kerosene lamp are sufficient to make one a microscopist, if he has the patience and perseverence to master the manipulation of them; he must learn not only "how to use" but "how to see."

Of eye pieces, a two and a one inch Huyghenian, and a half inch solid cover the demands of the upper end of my working tube.

With advancing years, past experience inclines me more and more to the use of the simplest means which will give the desired or sought for result. Should any of my "brother mics." differ with me in this, like the school boy, I crave they will "pass my imperfections by;" not from extreme youth but old age, though of sufficient vigor still to read under the microscope, with unabated interest, the volumes written by the pen of Nature.

IN one of her books Ida Pfeiffer says that any other woman might travel as much if she would leave her bandboxes at

home. It is always the bandboxes that make themselves obnoxious. Like the Englishman's bath-tub, they monopolize the traveller's attention to the exclusion of social civility and of landscape scenery. The microscopical traveler, especially at the beginning of his journey, is apt to accumulate bandboxes that like all such trash hinder his progress and ruin his temper. As he looks over the dealer's catalogues, that seem to be the schedules and the time-tables prepared for him by some superior being, he fears that he may omit some essential thing, and only succeeds in loading himself with bandboxes to be hurled out of the window after a few miles' progress. The novice that is forced to the other extreme by the weakness of his exchequer, and so starts empty handed, is in the end a happier traveler and a more learned man, than he that steps off with a handbox in both hands.

One of the failings of the microscopical community seems to be the accumulating of trash. Where the stuff comes from is often hard to tell, yet it comes. Misguided friends are often one ignorant cause, since they will persist in making Christmas presents of thin glass, that for thickness is first cousin to window panes. And it goes into the bandbox. Is there need of three or four thicknesses of cover glass? Is it not a good plan to use number one covers for all purposes? The skill to handle them is soon acquired, while the result is more pleasing and more shipshape, beside being to the advantage of the objectives that are always corrected for exceedingly thin glass.

Rings? Glass rings, and tin rings, and zylonite rings, and white metal rings, and brass rings, and curtain rings, and ebonite rings, and —— Oh, go to! Curtain rings flattened with a hammer, and a few deep circles of tin will leave space in the bandbox for the stains and cements sure to get there.

You were speaking of stains? Hæmatoxylin and ammonia-carmine, and borax-carmine, and picro-carmine, and Burrill's stain, and Gibbes's stain, and Seiler's sulph-indigotate of soda, and anilin violet and blue and green and red, and Bismarck brown, and vesuvin, and gentian violet, and methyl vio— alas, that life should be so short!

Mounting media? Dozens of them. Cements? They come by battalions, marching and counter-marching before the bewildered microscopist until in his desperation he selects

one or two of each, and with fiendish glee smashes the rest and dumps their remains into another bandbox. Glycerine, Canada balsam and a weak solution of chloral are about all the necessary mounting media. For cements, shellac, Brunswick black, and one of King's fine preparations will answer every purpose. Among the stains, hæmatoxylin and eosine are useful and trustworthy; for a double stain, picro-carmine easily holds first place. For the *Bacillus tuberculosis*, Burrill's stain is satisfactory and manageable. If the microscopist is going into bacteriology he will need a laboratory, and having reached that point he will be able to take care of himself. Yet even there he will accumulate bandboxes, unless he be discriminating and self-possessed.

Worthless or next to worthless objectives will sometimes get into the bandboxes where they become very, very, cumbersome. For this the dealers are secondarily to be blamed, primarily the purchaser that demands "high power," and gets it. But when he gets it, he is like Miss Edgeworth's naughty little girl with her blue china vase. Four poor objectives will in money cost as much as two good ones, and be sixteen times more useless. In the loss of educating experience and of the optical *tactus eruditus*, the cost is greater than any money can counterbalance. What the average microscopist needs is one good objective of low power, and one of medium high power. With a one-inch and a one-fifth the worker is well equipped even for some original investigation. At any rate, he will have two good lenses to "grow up to," and he will find that they will appear to improve as he ascends to their level. If he is to go into the resolution of Diatoms or into other "microscopical gymnastics," he will need special apparatus, and the rest of us will look on in silent awe as he searches for the "chalk marks on a white wall."

One of the writer's friends possesses this battery of objectives: a variable three to five-inch, a two inch, a one-inch, a $\frac{4}{10}$, a $\frac{1}{4}$, a $\frac{1}{5}$, a $\frac{1}{8}$ homogeneous immersion, a $\frac{1}{10}$ homogeneous, and a $\frac{1}{20}$ homogeneous. The cost was four hundred dollars, and the objectives are magniffcent, yet he rarely uses any but the one-inch with the $\frac{1}{5}$ and the $\frac{1}{8}$. These are all that he needs for his work; the others are therefore trash that must fill the bandboxes, and hinder his microscopical progress, since the cost might have been

expended to better advantage. For him these fine lenses are worthless, because he does not use them.

The accumulating of useless microscopical appliances is always to be deprecated, especially at the outset of one's career. The advanced worker is justified in seizing upon every advantage even the least obtainable and at any cost, provided the apparatus will help him, and provided it shall not hereafter take to itself one of Miss Pfieffer's discarded bandboxes. Near the top of the ever lengthening list of microscopical "Don'ts," should be placed 'Don't accumulate trash.'

ACKNOWLEDGMENT.—To Dr D. B. Ward, Poughkeepsie, N. Y., for three superb slides of Diatoms: *Aulacodiscus Rogersii* from Barnegat, N. J., *Coscinodiscus subtilis* from the Hudson river, and *Anthodiscus floreatus* from Oamaru, N. Z. The Diatoms are mounted on the cover and surrounded by a little ring of cement so that the microscopist can find them with no loss of time. The *Aulacodiscus* is perfection, even to the three or four marginal apparently tubular processes, their presence unbroken being an evidence of great care and skill in the manipulation.

NEWS · FROM · THE · WORKERS ·

In the *Journal of the Quekett Microscopical Club*, Mr G. C. Karop publishes a translation of a portion of a monograph by Dr W. Kopf, on certain parasites which were found infesting Diatoms obtained from bog pools in the sub-alpine region of Norway at a height of 1150 metres, although the same parasite has been seen on Diatoms in a small lake at the elevation of 600 metres, and may yet be found on those from the plains. The particular species affected was a *Pinnularia*, the infested individuals occurring in great abundance. Although the fungus resembles that already described as infesting Desmids, it is supposed to be sufficiently distinct to warrant the formation of a new genus, *Septocarpus*, which is relegated to the order Rhizidieæ.

In its sporangia the extra-matricular portion has more or less the shape of a long-stalked pear, and is not unicellular but is divided into two by a partition, the lower, slender part representing the stem, the upper ventricose one the sporange. In the latter are developed from fifty to eighty small swarm spores, and as these mature the vertex of the sporange becomes chemically altered, at their maturity the membrane being dissolved; the spherical swarm spores then escape, each being provided with a large nucleus and a posterior cilium.

The intra-matricular part consists of a delicate mycelium, which is obscured by the altered contents of the *Pinnularia* frustule, yet in completely exhausted host-plants it can be seen in its coarser ramifications, without the aid of reagents. Its effect on the host is of the usual character, the most striking changes occurring in the chromatophores, which become broken up and transformed into dirty red-brown or olive-colored clots, and in part altogether disappear.

The extra-matricular portion which consists of the pedicle-like cell and the spherical sporange, is formed from the swarm spore in the following manner: The pole directed away from the host developes into a cylindrical sac constricted above its base. The free end bulges out, the contents withdraw toward the bulged portion, and the transverse partition arises and separates the now empty stalk from the sporangial sac. It is this exceedingly peculiar development from the zoospore that has induced the author to place the fungus in a new genus. No resting condition of the plant has been seen, either by collection in the autumn or by cultivation.

The spots chosen for penetration into the Diatom are always either the non-silicified border between the girdle-band and valve, between the two girdle-bands themselves, or through the middle line (raphe) of the valve. The raphe is said to be a longitudinal cleft, otherwise the fungus could not penetrate the Diatom at that point, as it does, usually selecting that portion of the cleft near the centre of the *Pinnularia*, from six to ten individuals often being attached to each side of the frustule near that point. When the fungus invades very small Navicular forms, both mycelium and fructification are dwarfed. It also occasionally happens that the extra-matricular portion is not

differentiated into peduncle and sporange, but consists solely of the latter, which then developes very few zoospores.

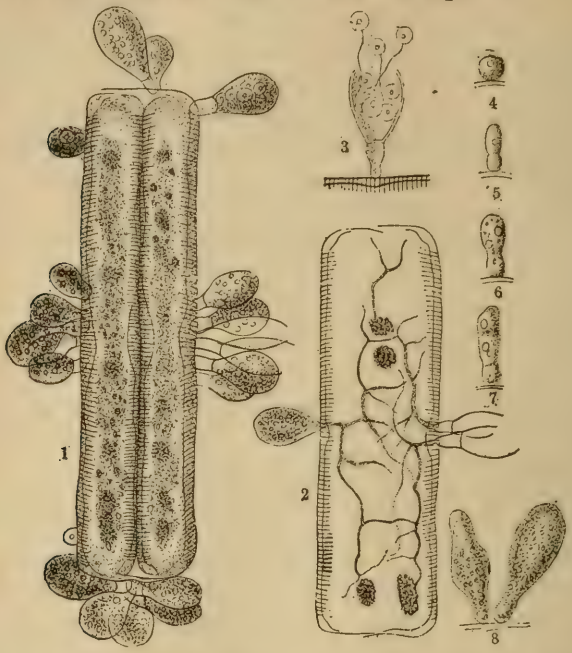


Figure 1 shows two connected frustules of *Pinnularia* in girdle-band view, with a number of sporangia attached to each. Fig. 2. *Pinnularia* frustule with separated girdle-bands. The fungus has penetrated through the raphes of both valves, the course of the mycelial threads being well shown. Fig. 3. A partly emptied sporange with zoospores. Figs. 4–8. Development of the sporange from the zoospore.

WAYS AND MEANS

BALSAM MOUNTS.

EDWARD W. SHARP, PH. G.

Canada balsam is probably more used as a mounting medium for microscopical objects than all others, and yet it is apt to be

very troublesome to the beginner as well as to the more advanced.

In the first place the balsam should be not too thick nor yet too thin, and, except for objects that will not stand any heat, should be the pure natural balsam; the hard dry balsam dissolved in chloroform, benzol, etc., should, in my judgment, be only used when absolutely necessary, by reason that the object is too frail to stand the heat of baking.

The nicest and cleanest way to handle the balsam is in the collapsible tin tubes Dealers in microscopical supplies furnish the filtered balsam in these tubes at twenty-five cents an ounce. I could never see why they should charge such an enormous profit for filling these tubes with balsam, as the balsam can be bought at retail for seventy-five cents a pound, and the tubes are worth less than two cents each. The amount to be used can by these tubes be graduated to a nicety, and if filtered no dirt can ever get in the balsam. It is needless to say that the slide and cover glass should be clean. I find the best way is to clean them just as you use them, using dilute alcohol and an old handkerchief. After cleaning, warm the slide to get rid of moisture, place on your turn table, and apply the balsam (or if the object is frail, float it on the slide before applying the balsam); the object after being placed on the slide can be covered with a little more balsam, it being best to use more balsam than will be required in the finished mount. The clean cover glass should now be held by the forceps near the flame of a Bunsun gas flame or that of an alcohol lamp, to free it from moisture, as well as to prevent air bubbles; then it may be gently lowered from one side over the object; a clip may be now applied, unless the object is too frail to stand the pressure of it. I find the best clip can be made from the ordinary steel hair pins by bending one part of it so it will lie flat on the bottom of the slide without turning over, and bending the other part at right angles so the point will press against the cover glass. Stray air bubbles and small pieces of dirt can be removed with a fine wire, after the cover has been applied. Disarranged objects can also be replaced by the same means. Baking the slide is next in order; the heat should not be very great. I find the best plan is to place the slides on a board, and put in the oven of an ordinary cook stove or range, after the fire has been fixed for the night; by morning, the slides

will be found to be baked just right unless the fire is very hot indeed; this can however be remedied by leaving the door open a little way.

The balsam when baked just right, will be found to chip off readily with a knife, with a slight tendency to be tough next to the edge of the cover glass. The slide can be best cleaned with a sharp pointed pen knife, and while cleaning, an old tooth brush is of great service to brush off the dust and chips to see what you have been doing. After roughly cleaning in this manner I take a shallow dish, fill it with alcohol, and with a short stubby camel's hair brush, go over the whole slide and cover until it is judged to be clean, when it is put in a large dish of water. After all the slides have been cleaned in this manner, I take one by one and wipe dry with a towel. They are now ready to be ringed. No slide intended to be kept permanently, should fail to be well ringed, as the balsam may evaporate, and the mount is much more liable to become loosened, to say nothing of the finished appearance the ring gives a slide. Whatever is the cement used, the first coat or two should be of some kind of a transparent cement, as should it run under the cover it will not show differently from the balsam, while a colored cement will.

The following formula for a transparent cement, copied from "Packard's Entomology for Beginners" has been found so good that I can recommend it.

Gum dammar	5 drams.
Gum mastic	3 "
Canada balsam (dried)	3 "
Chloroform	1 fluid ounce.
Spirits of turpentine	1 " "

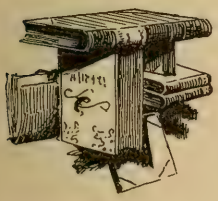
Mix; dissolve by shaking occasionally, and filter through paper.

This cement can, if desired, be thinned by adding a few drops of an anilin dye, dissolved in alcohol; red, green, violet and brown are good.

The heavier the ring the safer is the mount. I generally put on two coats of the transparent cement, and finish with two or three coats of the tinted, letting them dry a day or two between each coat. A slide prepared in this manner, and finished as described, will be as permanent as the glass slide on which it is prepared.

TO TRANSFER DELICATE OBJECTS.—Delicate objects floating in liquid, as for instance, fungi on a dead insect, are very difficult to transfer to a slide without disarranging them, and rendering them useless for observation. I have for some time been employing this simple method with much satisfaction. Crowd a wedge of cork or wood between the springs of a pair of pliers, separating the points about $\frac{1}{8}$ of an inch, and place a cover glass of a diameter slightly larger than the distance between the points of the pliers, transversely, so they will lightly grasp its edges; taking hold of the top of the pliers, dip into the water a little to one side of the object you wish to secure, and carefully bringing it under the specimen lift it from the water. You can then drop the cover and object on a glass slip, specimen upwards, or what is better, make a holder of a slip of wood, or even of card-board, with an aperture somewhat smaller than the cover glass.—E. L. CHEESEMAN.

TO CATCH AND KILL SMALL INSECTS.—Take a wide-mouthed bottle, fill it half full of cotton; after saturating the cotton with chloroform, put on the cotton and in the bottle, a round piece of white paper or paste-board; hold the mouth of the bottle over a sitting insect and within one minute it will lay dead and clean on the dry, protecting paper.—DR CARL H. HORSCH.



NEW PUBLICATIONS

MODERN SCIENCE AND MODERN THOUGHT; With a Supplementary Chapter on Gladstone's Dawn of Creation and Proem of Genesis, and on Drummond's Natural Law in the Spiritual World.—By S. Laing. 2 Vols. 8vo., pp. 111, 187. New York: The Humboldt Publishing Company.

These two small volumes are an attempt by a well known writer, to sum up the recent results of scientific research, and to show how widely these results have modified the world's thinking on philosophical and religious subjects. Mr Laing writes for

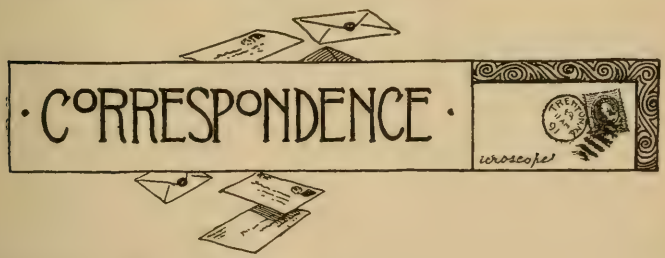
those who have no time for voluminous works, and he succeeds in putting what he has to say into clear language and into brief compass. The author pretends to no originality in the first part, which outlines the achievements of science, and he scarcely reaches any in the second, which deals with the revolution these achievements are supposed necessarily to effect in religion. He depends almost as fully on Huxley and others for his opinions as for his facts. He states the results of science with tolerable accuracy, though he accounts as scientific a few things which others as well qualified to speak would regard as speculative. His conclusions respecting the modifications of religious faith by the progress of science are somewhat radical, and would be called in question, not only by theologians, as he should expect, but by many learned laymen as well. Altogether, it may be said that this work, whose spirit and tone are admirable throughout, is a valuable contribution to recent literature; and while it would not be a safe guide for those who depend on authority, it may be commended to those who have intelligence and independence enough to think for themselves.

ALL AROUND THE YEAR–1891. Designed in Sepiatint and Colored by J. Pauline Sunter. Printed on heavy cardboard, gilt edges, with chain, tassels, and ring. Size, $4\frac{1}{4} \times 5\frac{1}{2}$ inches. Boxed. Price, 50 cents. Boston: Lee and Shepard.—Of all the calendars of the year this is the prettiest, the dantiest, the most refined that I have seen. It is formed of a collection of heavy gilt-edged cards fastened together loosely by a silver chain so that each may be turned back when the new month comes in, and in addition to the days and the dates, each contains an artistic picture in delicate colors, the actors in the scenes being little children depicted with a grace that is charming. The whole calandar is a work of art.

INVERTEBRATE DISSECTIONS.—By Henry L. Osborn, Ph. D. Square 16mo., pp. 36. Published by the author, Hamline, Minn. Price 40 cents.—"Experience has demonstrated," says Prof Osborne, "that the beginner in Zoology can learn a great deal with such simple tools as scalpel and hand lens, which can be had by anyone, and with these penetrate far into Nature's secrets." This is the key-note of the little book that is all work for pocket lens and naked eye, with those explicit directions and

suggestive hints that the good teacher and the learned writer knows so well how to give, and that are so welcome to the earnest pupil. For instance, under the fresh water brown Hydra, *H. fusca*, the author directs: I.—Pour the alcoholic specimen into a watch glass in water; place on a dark ground. Obesrve: 1, body cylindrical in form; 2, the long threads, *tentacles*, situated at the *oral end*; 3, the blunt *aboral* end or *base;* 4, in some specimens on the side of the body near the aboral end a *bud.* II.—Slice across the body with a scalpel at the largest place, cut again across the cut end, removing thus a cross section. Mount the section in water, and examine with a hand lens. Observe: 1, the body is not solid, but hollow; 2, the skin or wall of the body is composed of two distinct coats, viz.: *a*, an outer coat, thin, smooth and regular—*ectoderm;* *b*, an inner coat, thick and irregular—*endoderm;*" with more that, like the foregoing, might easily be overlooked by the beginner who is here told how to look and what to look for. Among several marine animals, Prof Osborn in this commendable way treats of the angle worm, the fresh water mussel, the slug, the pond snail, the cray fish, the sow-bug, the spider and the grass-hopper.

While the little pamphlet is primaaily intended for college students attending a course of lectures it may be used with as good results by the pupil that has himself for a teacher; with it to direct him he will be helped to observe and to compare. Of the nineteen animals included, eight are marine, four aquatic and seven terrestrial, so that no one, wherever he may be, need ever be at a loss for material to study.



EDITOR THE MICROSCOPE:—

"Amateur" has written so discriminatingly and instructively for the year past that his strictures upon the Wenham binocular in a late number were a real surprise. Having no practical ac-

quaintance with the Zeiss binocular eye-piece, and having reason to believe that not one is to be found in California I cannot comment upon it; but the Wenham form is my every-day companion. If "Amateur" has experienced "unpleasant strain upon the eyes and weariness after long use," such statement leads to the conclusion that he must be unfortunate in the instrument used. For the last ten years have taught the writer that there is a very perceptible difference in the work of different makers as relates to the binocular body-tubes. In 1880 I became acquainted with a Crouch binocular of high grade. This was regarded at the time as especially good; but it was not easy to obtain stereoscopic effect, and with some it was unattainable. A younger brother of my own was one of such persons. Since then the binoculars of Zentmayer (Histological) and of Beck have become more or less familiar; while for five years past I have owned a Bausch and Lomb Universal binocular, which has proved perfect in respect to freedom from strain upon the eyes and to excellent stereoscopic effect.

The first time that my brother alluded to, looked through this "Universal" he exclaimed that now at last he had realized the stereoscopic effect.

The item in the workmanship which made all this difference was simply that in my own instrument due provision is made for approximating the eye-pieces near enough to suit all eyes. When the axis of the oculars is adjusted to the observer's eyes, prolonged use can be carried on comfortably and beyond the range of a moncular. This, too, is really the main advantage of the binocular; for there are those who care little for the stereoscopic effects, or who are prevented by some defect of eyesight from realizing it.

The matter may, for the presnt, be summed up somewhat as follows. Advantages of the Wenham form: the simple swinging of a prism to change into a monocular; lower price, because of less complicated construction; capability of use with several pairs of eye-pieces giving a range of magnifying powers; saving of weight and larger area of field. Advantages of the Abbe binocular eye-piece: variety of effects produced; availability with any power; avoidance of double body-tube; lessened fatigue(?) of observations.

Even with the correction of the faults of the binocular eye-piece, mentioned in "Amateur's" article, I believe there will still be a place for the Wenham binocular. If the Abbe binocular is superior to the Wenham form it will make its own way, and be welcomed by the writer as well as "Amateur" to the circle of observing microscopists.

BENICIA, CALIF. EDWARD GRAY, M. D.

THE MICROSCOPE
AN ILLUSTRATED MONTHLY MAGAZINE.

VOL. XI. TRENTON, N. J., FEBRUARY, 1891. No. 2.

ORIGINAL COMMUNICATIONS

THE HISTOLOGICAL DIFFERENCE BETWEEN BONE AND THE ENAMEL.

F. A. ROGERS, M. D.

Among the one hundred thousand living species of animals and a like number of plants, not one of this vast multitude has ever been known to produce a structure unlike its kind.

No seed of corn has ever yielded oats, no turnip a potato; no pine an apple; the egg of a hen never hatched a turtle or a frog. Throughout Nature like begets like, and this inexorable law holds good in minute cells and their products as well as in complex organisms. The physical germ we may see and study, but the spiritual hand which guides the germ we cannot discover though we may trace its expressed action upon material things.

We may watch microscopically the changes produced by the vital power in living matter and, although we have not yet discovered the power which directs the cells of tissue in the embryo pursuing their various selective courses, yet a study of the progressive changes of contour, arrangement and position manifest in developement must ever be interesting to the student of Nature.

1 Read before the Barnstable District Medical Society.

Doubtless every physician has asked himself the question when a patient has applied to him to relieve an aching tooth. Why cannot the enamel of the tooth be replaced by repair or growth as bone or other tissues? Every surgeon amputates a limb with the assurance that the end of the bone will heal over. The fractured limb will unite under proper treatment, and coaptation of the parts, or in other words the separation of the continuity in bone will be replaced by new bone, but when the enamel of a tooth has been fractured or destroyed the reparative process is wholly wanting, and unless some artificial process is resorted to the wound increases until the tooth or its usefulness is destroyed.

Close as the analogy may appear to the casual observer, a wide disparity is seen to exist when we study the origin, development and appearance of each in detail, and it is only when we have followed out this, that we can give any valid reasons which will answer the foregoing question.

From a few human embryos, and also from several small animals, I have mounted many hundred sections of bone and of the inferior maxilla which, when contrasted have suggested the theme of this paper. These embryos had been preserved in ordinary alcohol, some of them for several years. The part which I wished to study, as for instance the lower jaw, was carefully dissected out by cutting from the angle of the mouth through the cheek directly back to the ramus and disarticulating from the temporal bone, then dividing at the symphysis mentis and removing the tongue; each part was placed in borax-carmine staining fluid for twenty-four hours, then into the discharging fluid for twenty-four hours, after which the specimen was treated with each of the following for twenty-four hours, successively: alcohol 95 per cent., alcohol absolute and chloroform; after this it was transferred to paraffin kept at the temperature of from 115° F. to 125° F. for six hours, then after suddenly cooling the paraffin with the specimen within, it was transferred to the microtome and sectioned as desired. By using care in trimming the paraffin close to the specimen and in such a way that a section across the top would be a small square I have succeeded in mounting from sixty to eighty consecutive sections under one $\frac{3}{4}$ inch cover glass. The mounting was done as follows.

The size and position of the cover glass in relation to the slide

having been outlined in paper, the glass slide was lightly smeared over with a fixitive of egg-albumen 2 parts, glycerine 1 part, and placed over the outlined paper. Upon this slide the ribbon of sections was arranged to read like the lines of a book, and gentle pressure with the finger tips fixed them in place. The slide is heated until the paraffin melts, then it is immersed in benzol when it remains five minutes, or until the paraffin is dissolved, when it is cleared in oil of cloves and mounted in balsam.

In order properly to differentiate bone and enamel let us briefly consider the development and structure of each. What is bone? "Bone is simply an aggregation of calcospherules" (I quote this and several of the following passages from Sudduth). The calcospherules are but houses occupied by the osteoblasts, a specialized cell destined to perform a special work, namely that of building the bony spherule which is called the calcospherule. Before the osteoblast begins to perform its function as a bone-builder by throwing out a thin covering, thus completely encasing itself, it has attained its greatest size and from this time on the covering or calcospherule grows at the expense of the osteoblast, so that a section of newly formed bone will reveal a mass of calcospherules united in no regular order, and the osteoblasts may frequently be seen lying within, having been reduced to one-third or one-fourth of their former dimensions. (See Fig. 1, o.)

Each osteoblast secrets its calcospherule, and when this process is complete, its work as a bone-builder is at an end; from this time onward it simply "occupies the house it has constructed," ready, should occasion require, to repair any damage which may be done to its individual bone. From this it might be inferred that each osteoblast lived the life of a hermit, having no communication with its surroundings. Such is not the case. When the calcospherule is being formed, the osteoblasts, which previously were in contact with each other, do not break up these points of contact but permit them to be drawn out into fine processes, and these continue to establish a union between the cells of bone.

The canals in which these processes lie have been known as the canaliculi, the interior of the calcospherules themselves as the lacunæ, while the capillary circulation in bone comprises the "Haversian canals." From these canals, through the intercommunication of the processes, the osteoblasts receive nutrient material.

This now brings us to the consideration of the various ways in which bone is developed. Different authors classify the development of bone differently, but as it is the intention of this paper to show the difference as a whole between bone and another substance, the selection of two classes of development will suffice. The selection which has been made and illustrated in Figs 1 and 2, represents a type of intramembranous and intercartilaginous development. In both figures the calcospherules and contained osteoblasts are plainly seen. In Fig. 2 the contour of the cells is more regular and at the left of the figure cartilage cells may be noted.

After briefly noticing the structure and development of bone, let us ask the question, Whence originates the osteoblast? Sudduth says, "In the first instance I am pretty fully convinced that they are the ordinary embryonic connective tissue cells." Here he refers to his classification of "Interstitial development;" again, "In some instances osteoblasts are produced from connective tissue cells; sometimes they have their origin in cartilage cells;" and again, "Connective tissues arise from the mesoblastic layer of the blastoderm." One thing seems to be conclusive, that all forms of bone development are the product of the mesoblast or middle layer of the blastoderm. In the study of the enamel organ we shall first notice that it originates from the epiblastic or outer layer of the blastoderm. The two layers which originally comprise the blastoderm are known as the epiblast and hypoblast. Very soon after incubation in an egg another layer known as the mesoblast appears; from this layer as we have already noticed, bone is derived. It remains for us now to consider one of the interesting products of the epiblast.

The nails, hair, sebaceous glands, enamel organ, as well as the epidermis, are alike products of the epiblast layer. No one has yet been able to say why the cells of this same layer should produce hair in one place, nail in another, sebaceous glands in another and the mucous membrane and teeth with the dense enamel in very close proximity elsewhere. Especially when in its incipiency the epiblast bears such a striking resemblance to the adjacent mesoblast, yet if the process of development be not interfered with, the greatest contrast results in their product. At an early period differences can be shown between these layers. The epiblast stains more readily and darkly than the mesoblast,

and more space exists between the mesoblastic cells than between the others.

In Fig. 4, both of these statements are verified, also it will be seen how easily the two layers may be separated artificially. In its incipiency the inferior maxilla arises from two lateral bud-like processes composed of mesoblastic cells nearly surrounded by an epiblast or infant layer. These unite in front, forming the symphasis mentis; and running through and occupying a central position Meckel's cartilage may be found.

Upon the crest of the gum, in the infant or epiblastic layer which covers it, may first be seen active cell-multiplication which results in a depression or a growing of this layer into the connective tissue beneath. This is illustrated in a transverse section. (Fig. 3, x). At certain points along this groove the cell-multiplication increases more than at other parts, causing bud-like processes which extend into the connective tissues beneath forming cords which correspond to the enamel organs of the several temporary teeth.

At the commencement of this infolding of the infant layer the band is broad; from one side a lamina is given off which develops into the cord. This develops rapidly, sinking deeper into the mesoblastic or connective tissue, and while at the point of origin it is narrow, at the bottom it broadens, assuming a club or pear-shaped appearance.

It is made up of a solid ingrowth of cell formed, as just explained, from the lamina, which arose from the band and which in turn originated from the infant epiblast or epithelial layer of the mouth. In a short time the bottom of this cord becomes flattened and finally invaginated by contact with the mesoblastic cells, which now assume new characteristics and become known as the dental papilla, or the future pulp of the tooth. (See Fig. 5, q). The cord and dental papilla now oppose each other in growth, one growing downward into the jaw, the other upward or toward the gum. As a result we have an organ known as the enamel organ, made up from two kinds of cells, epiblastic and mesoblastic, united to accomplish one end, viz., that of forming the tooth.

This combination, one of the most striking in the animal economy, from this time onward forms a new, independent creature, so to speak, and the result is a product unlike that found

elsewhere among mammals. We will notice briefly the organ as a whole, and separately the outcome of each class of cells.

As a combination the enamel organ sinks deeper into the tissues, and the neck of the cord grows smaller and narrower until finally it separates from the mother epiblastic layer entirely. The organ is now wholly beneath the surface where it is entirely surrounded by mesoblastic cells, as illustrated in Fig. 6. The dental papilla pushes its way onward and upward carrying the two epiblastic layers, now known as the outer and the inner tunics, nearer together at the apex of the tooth.

A moment's reflection will substantiate the fact that the cells which are enclosed by the tunics are simply epithelial cells derived orginally from the mucous membrane of the mouth, lying as they did originally upon the surface and being a part of the epiblast. In the original from which Fig. 6 was taken, the cells around the inner edge next to the tunic, as at k, Fig. 6, are distinctly epithelial in appearance, while those in the interior, as at j, are changed to a stellate form; this is now known as the stellate reticulum. But it is at the point where the papilla and the inner tunic of the epiblast are striving for the mastery of position, so to speak, that the most wonderful changes occur.

Between the surface of the enamel organ and the dental papilla, no union occurs; simply one surface is perfectly adapted to the other. Authority states, that "Vessels or nerves have never been demonstrated to pass from one to the other," and from the fact that the enamel and dentine, both of which are products of these organs, can be very easily separated from each other, it is proved that no union was ever established.

At this point the shape of the cells which lie in opposition, as at g, h, Fig. 6, or o, s, Fig. 7, are changed very materially. They become crowded together into line, losing their oval form and becoming columnar or prismatic.

The cells of the inner tunic are now known as the ameloblasts, while the terminal ones of the dentinal papilla are known as odontoblasts. Between these layers of cells are formed the dentine belonging to the odontoblasts while the enamel is formed under the superintendence of the ameloblasts. (See Fig. 8 a, and o).

Up to this time we have only considered the formation and development of the temporary tooth. The permanent tooth is

developed in much the same way, only the cord is longer and more slender.

It arises from the same infant layer, generally from the same cord as does the temporary tooth, and directs its way down between the tooth and follicular wall, behind the temporary tooth; there it undergoes the same process as its antecedent. (See Fig. 6 c).

The deposition of enamel and dentine is from one end only of their respective cells, and only in a direction toward each other. In this respect bone development differs very materially, for we have noticed that in the development of bone the osteoblasts do not become themselves calcified, but the lime salts are deposited around the osteoblasts in the calcospherules, thus completely encasing them. In the development of dentine, although the odontoblasts do not themselves become calcified, yet the dentine is deposited only from around their fibril ends in a tubular form. The deposition of enamel is in much the same way; the ameloblasts are not themselves calcified, but they deposit the prismatic enamel from the end next to the odotoblasts. (See Fig. 8, e, d).

The dentine consists of a solid mass of calcified tissue arranged in a tubular form around the fine processes of the odontoblasts. The enamel is a still more condensed structure of calcarous matter consisting of hexagonal prisms arranged side by by side and very closely together. "I look upon enamel as nothing more or less than a coat of mail supplied by Nature to protect the dentine and subserve the process of mastication" (Sudduth).

Before the tooth issues from the bed of the jaw, the outer tunic has completely disappeared, and the enamel upon the apex of the tooth having been fully formed, the ameloblasts which produced it, having served their purpose, have also disappeared, so that whatever injury is done later to the enamel no provision is made for its repair. Then briefly to recapitulate. We have noticed how that bone originated from one class of cells, the enamel from another; how that early in embryonic life a difference is seen in the appearance and course taken by each class of these cells; how that working together in one organ they produce results unlike the product of either separately. And upon the theory that one

kind of cells cannot produce another kind, we recognize the early manifestations of that natural law which keeps them separate, yet wonderfully harmonizes and adapts each to the other in one product, the tooth. After having briefly contrasted the origin and development of these tissues, we will conclude by answering the question asked at first, by saying that in the formation of most tissues provision is made for repair. In bone by the encapsulated osteoblasts ready when called upon to secrete, as in the development, calcareous matter; while in the enamel the source of the supply of material being lost in the disappearance of the ameloblasts and rupture of the tooth through the gum, no provision is made by Nature for repair should this interesting structure be destroyed.

EXPLANATION OF FIGURES.—PLATE I.

FIG. I.—X 50. Section through the parietal bone of a two months human embryo, showing the osteoblasts *o*, and calcospherules, *p*.

FIG. II.—X 750. Horizontal section at the junction of a rib and transverse process of a dorsal vertebra in a two months human embryo; *g*, osteoblasts; *h*, calcospherules.

FIG. III.—X 100. Transverse section through the inferior maxilla of a six weeks human embryo; *w*, epithelium; *x*, band for future tooth; *y*, infant layer; *z*, Meckel's cartilage; *v*, developing bone.

FIG. IV.—X 300. Transverse section through the inferior maxilla of a two months human fœtus; *a*, infant layer, epiblasts accidentally separated from the mesoblasts; *b*, epithelium; *c*, band; *d*, cord for tooth; *e*, connective tissue mesoblasts; *f*, Meckel's cartilage.

FIG. V.—X 65. Transverse section through the inferior maxilla of a three months human fœtus; *k*, epithelium; *m*, neck of cord; *n*, infant layer, *o*, outer tunic; *p*, inner tunic; *q*, dental papilla; *r*, developing bone; *s*, Meckel's cartilage.

FIG. VI.—X 125. Transverse section through the iuferior maxilla in the region of a cuspid of a 4 months human fœtus; *a*, epithelium; *b*, infant layer; *c*, cord for permanent tooth; *d*, outer tunic; *e*, inner tunic; *f* dental papilla; *g*, odontoblasts; *h*. ameloblasts; *j*, stellate reticulum.

FIG. VII.—X 65. Transverse section through the inferior maxilla, region of a molar, of a young mouse two or three days old; *l*, epithelium; *n*, outer tunic; *o*, ameloblasts; *p*, dental papilla; *s*, odontoblasts; *t*, hair follicle.

FIG. VIII.—X 1000. Enlargement from Fig. VII at the point *m*; *a*, ameloblasts; *b*, stratum intermedium of Hanover; *t*, Tomes' processes; *e*, enamel newly formed; *d*, dentine; *o*, odontoblasts; *s*, dentinal papilla.

FIG. IX.—X 350. Section through the tip of a human incisor; *s*, enamel prisms; *t*, dentine. The section was ground as thin as possible and afterward treated with dilute hydrochloric acid, 1 to 500, to separate the prisms.

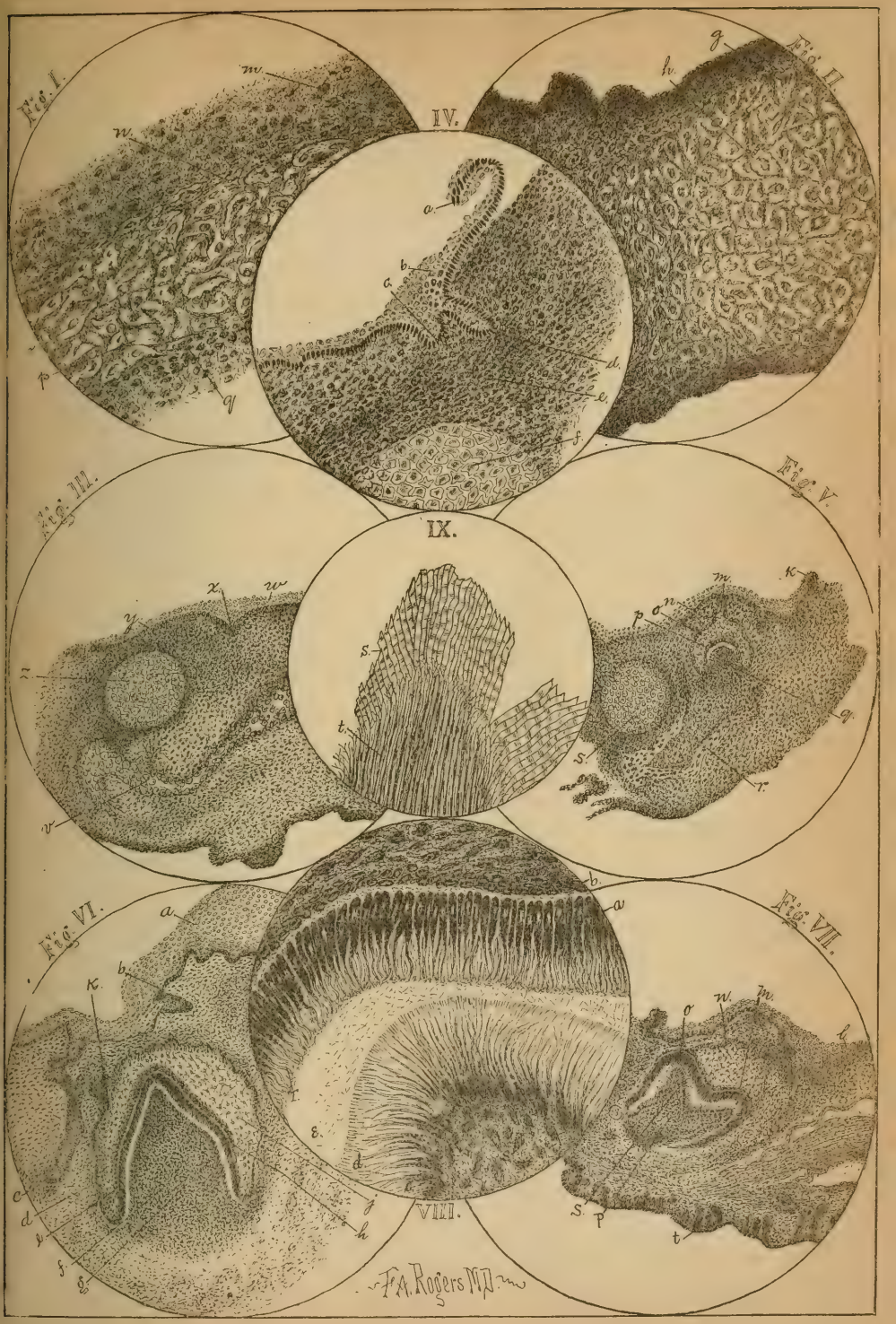


Fig. I.
m
w
p
q
IV.
a
b
c
d
e
f
Fig. II.
g
h
Fig. III.
x
w
y
z
v
IX.
s
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Fig. V.
m
k
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Fig. VI.
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VIII.
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Fig. VIII.
o
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P
t
F. A. Rogers M.D.

All the figures, except Fig IX, were drawn from photographs made by the author, and in his possession. The sections were borax-carmine stained; Carbutt's instantaneous plates were used for making the negatives; B. & L. $\frac{3}{4}$ and $\frac{1}{5}$ objectives, student series, and J. W. Queen & Co.'s $\frac{1}{15}$ oil immersion were used for photographing. Fig. IX was drawn by means of a camera-lucida.

CYTOLOGY, OR CELLULAR BIOLOGY.

II. METHOD OF CYTOLOGY.

REV A. M. KIRSCH, C. S. C.,
PROFESSOR OF BIOLOGY IN THE UNIVERSITY OF NOTRE DAME.

IN the first paper on Cytology it has been indicated that the method of studying Cellular Biology must be above all practical. No lesson in Cytology can be given outside of a microscopical laboratory, where every student is required to make his own preparations as is necessary for the proper understanding of the professor's instructions.

It would certainly be a ridiculous pretention to imagine that one can give theoretical instruction in Cytology to students who never have seen a cell or who never will see one during such a course. Such instruction could never produce any intellectual fruit. It may be of interest to many to know the manner of proceeding in a lesson in Cytology. Here is briefly the programme observed in every sèance in the Cytological laboratory of Prof Carnoy at the University of Louvain.

First, the professor announces briefly the subject of the lesson, then the material is distributed and a few indications are given as. to the manner of preparing it. Then begins at once the student's personal work.

Next, the professor and his assistants, of which there are as many as five or six, pass from microscope to microscope and control, correct and direct the work of every student. Questions are asked and alternately answered by student or professor, and thus during a five minute's conversation, the students gain more real knowledge than they would in an hour's lecture.

The professor's chief endeavor is to awaken in the student a spirit of observation, a certain relish for personal work, and sometimes an enthusiam which produces happiest results; thus everyone is initiated into the true scientific method of acquiring knowledge.

Every student is required to draw the object according to his own preparation, and this gives him a means of comparison be-

tween his preparations and those of his neighbors; notes are also compared; disputes arise and the professor is appealed to for a decision. In this manner, I have sometimes seen that three or four preparations were studied in a single séance, lasting about two hours.

At the end of each lesson the professor devotes a few minutes toward the summarizing of the work, and a synthesis is given embodying all that was observed during the lesson.

I have seen as many as one hundred and twenty students at work in the laboratory, and naturally concluded that to control and direct every worker must cause great fatigue to the professor. This he does not deny. "But then," he says, "the reward is great, and this strengthens me more and more in my resolution never to give a lesson in Cytology outside of the microscopical laboratory."

Now let us apply this programme and by an example show how the biology of a simple monocellular living being is acquired. Take for example *Noctiluca*, that charming phosphorescent Infusorium of the ocean.

What in this minute animal at first strikes the observer's eye is no doubt its beautiful peach-like form with the deep groove on one side. Focussing the instrument carefully on this groove he discovers an oral opening the mouth near which arises the tentacle or flagellum. This is a sort of a flattened cylinder, sometimes undulate or even recurved.

Evidently the student is now studying the general morphology of the cell; and examining the form of every part of the animal he studies the special morphology. Who knows but that the student now asks himself whether this has always been the form of the *Noctiluca;* and immediately he searches for the embryonic forms of the animal, in order to solve his doubt. Probably he wants to know how the mouth and tentacle are formed; and finally he may place the animal into another medium, as fresh water, to see what changes it will undergo. All this time he has evidently studied the complete morphology of the little creature. But by this time the student's curiosity is aroused and he is not satisfied with such a superficial examination. With the hand on the fine adjustment screw he with his eye penetrates the interior of this living pearl and endeavors to decipher the characters of its organization. Having observed the

admirable net-work and the refringent granules of the enchylema, or that soft and plastic substance filling the meshes of the net-work, he then turns his attention to the central mass of protoplasm, where he discovers the nucleus containing shining, irregular and fragmental bodies. Next he explores those darker looking masses, of an irregular outline, and soon he discovers that some contain embedded cells of Algæ and others hide the curiously sculptured carapace of some Diatoms. No doubt, these are not parts of the animal nor are they formed by the protoplasm-like inclavata, but must have been introduced from the surrounding water, and such foreign bodies introduced into the cells, we call inclusions.

After this, the student directs his attention to the limiting membrane of the cell and seeks to make out its structure and to trace its relation to the net-work or the reticulum. Finally he examines the mouth and the tentacle or flagellum. He is not a little astonished to find in the latter transverse striæ similar to those of muscular fibres in the higher animals, and he notices also its relation with the central protoplasm by wavy fibres of the reticulum. All this while the student has been studying the anatomy of the *Noctiluca*. But this is not all. Whilst pursuing his observations thus far, the student could not help seeing that the *Noctiluca* moves; and the anatomy of the creature enables him now to begin the study of its movements. First, he observes the most apparent movement, that by which it progresses from place to place, and then he investigates the manner in which this is effected, studying at the same time the mechanism, the laws and the causes which control this movement. Of course he finds the chief cause in the flagellum, but possibly he will suspect that this organ might be used also for the prehension of food? What a rich field for observation! But these observations would not be complete, were he not to direct his attention to the interior movements of the protoplasm. What life! What activity! Here and there he sees the threads of reticulum disappear and reconstruct themselves anew in a different direction, shooting out new threads like pseudopodia. He has seen the close relation of the reticulum with the interior striate substance of the flagellum, and he suspects that the motor tissue of all animals might be explained by considering the cells that compose it as chiefly made up of the net-work of protoplasm.

leaving those cells containing chiefly enchylema for the elaboration of food. What insight he thus gains into the physiology of living organisms!

But he has not yet seen all, for if he is very attentive he soon notices the little grains in the enchylema; how they promenade along the threads of the reticulum with an activity which varies every moment. Mysterious phenomenon! Who will explain it? Why? A very torrent of questions presents itself, all serving as a stimulus to the imagination. Now if the *Noctiluca* is irritated by gently tapping with a needle on the cover glass or by sending a slight current of electricity through the water, it will be seen that the protoplasmic reticulum breaks loose from the cell-wall and contracts toward the centre, at the same time dragging with it the granules of the enchylema and expelling the water from the plastic vacuoles. At last the observer may wish to find out the chemical nature and composition of the various parts of this curious Infusorium. He treats his *Noctiluca* to a minute dose of osmic acid and finds that the larger granules of the enchylema are stained black like ebony, an indication that they are of a fatty nature. Next he introduces under the cover-glass a drop of methyl green which at once siezes upon the fragmental portions of the nucleus producing a beautiful green color, and convincing him that they are nuclein. Other arrangements are used to find that the reticulum is formed of a substance called plastin, and the membrane of another called elastin.

Now if the observer will filter some sea water so as to obtain a quantity of *Noctiluca*, he can subject them to macro-chemistry and discover the presence of some soluble ferments as diastin and pepsin. Let this much be said to show what is meant by the modern science of biochemistry.

We thus see what is understood by a complete biological study of a living body. It is unnecessary for me to say that this study may be applied to every living being, to every group, and finally to all living organisms, and that thus we would have the study of general biology.

But from what has been said, this study may also be applied to every cell either as a complete living being or as a simple elementary individuality of organized beings. In this way we have the science of general Cytology.

Now, as I have already said, the cell is the ultimate constituent of every living organism, and a knowledge of the cell is the foundation of all biological science; it is, therefore, unnecessary for me to insist any longer upon the necessity of Cytology as a foundation for all ulterial biological study.

But I must also call attention to the fact that organisms perform their functions under two conditions, one normal and the other abnormal or pathological. Now as the functions of an organ or of the whole living being are merely the resultant of the combined functions of the constituents of that organ or being, and these constituents are ultimately the cells, it becomes apparent that Cytology is as necessary to the pathologist as it is to the biologist. If medicine is ever to be organized upon a scientific basis, it certainly must be founded on Cytology, for the pathological state of an organ results from the pathological state of the cells that compose the organ. Cytology, therefore, is above all necessary to the student of medicine.

Let us now see what should be required of our candidates for the study of medicine or of general biology. It would require two years of preparation, and in the first year the student should pursue: 1. A course of experimental physics, two sessions. 2. A course of general chemistry, two sessions. 3. The elements of botany, one session. 4. The elements of zoology, one session.

In the second year the programme should be as follows: 1. Cytology and general histology. 2. Comparative morphology of animals. 3. Anatomy consisting of: *a.* Human anatomy, two sessions. *b.* Human physiology, two sessions. *c.* Biochemistry of man, one session. *d.* Psychology, one session.

NOTE ON CAJEPUT BALSAM.

DR EDWARD GBAY.

CAJEPUT-BALSAM is a new thing in the armament of the microscopist, and its object is to curtail the process of mounting by doing away with the use of absolute alcohol and oil of cloves. Its origin is due to Dr A. C. Stokes the Editor of THE MICROSCOPE, who suggested to the writer to make trial of the article. As a clearing agent the oil of cajeput has deserved a wider use than it has obtained. Davis, in his "Practical Microscopy," states that one volume of it absorbs eleven

volumes of alcohol, and is thus eleven times more efficient than the oil of cloves.

The process of mounting then is to soak the object in alcohol, and transfer thence directly into the cajeput-balsam. The results are, to the writer, very pleasing. The mounts so prepared are not numerous, but comprise such divers objects as Diatoms, insect preparations and plant sections. A caution to be observed is that the preparations shall be well freed from water, also from oil. In either of these cases it would be prudent to transfer the object to cajeput oil from the alcohol[1], and thence into the cajeput-balsam rather than direct from the alcohol. A *slight* turbidity in the new mount will disappear in a few days.

To prepare cajeput-balsam the following process was found satisfactory. A given quantity of good Canada balsam was evaporated in a Berlin capsule to the consistency of thick syrup, which on cooling becomes hard and glassy; this was then reheated slightly and oil of cajeput added in quantity sufficient to bring the mass to the required fluidity (about 40 per cent of the original volume).

To any who may find the odor of the cajeput distasteful, the oil of eucalyptus may be commended in place of cajeput. Eucalyptus-balsam was prepared by the writer, but is as yet untried.

A LESSON IN MICROSCOPICAL SCIENCE.

THE REV J. W. SANBORN.

MICROSCOPICAL science, like medical skill, is not in a high state of advancement among some tribes of North American Indians. A few years ago I made an attempt to awaken an interest in microscopical investigation among some Pagans of the Seneca tribe. My reasoning was on this wise: "Since the Indians are near to Nature's heart, they may like to get nearer, through the medium of my microscope."

The Pagan medicine-men had suffered me to witness their method of curing a head ache. I was sanguine that a look through my instrument would correct some of their false notions, and perhaps modify the superstition which lay at the foundation of their medical practice. To complete the story of the headache: A dozen men, wearing hideous wooden masks decked with horse-tail wigs, and each carrying a rattle made

1 This is the proper method in every case.—Ed.

from the whole shell of a turtle, and filled with dried cherry pits, rushed into the room where lay the victim of the head ache. Screaming, hooting, rattling of shells, and burning of fine tobacco dust, constituted the dose. The Indian theory is that any pain is due to the devil's presence, and their united demonstration on this occasion was for the purpose of scaring the devil out. Surely, if anything would startle him, these pow-wows would. The head ache departed at all events in this case.

I called the Indians about me to look into my microscope. One broad-shouldered six-footer insisted on holding the instrument up to take a view of the Cattaraugus creek in the valley. I held the microscope down, and gave them their first lesson in the use of the instrument. They passed in silent and solemn file around the table. I had temporarily mounted the end of a louse's foot—it is not necessary to explain how or where I procured the specimen, but they all seemed to know the creature.

Each Indian gazed long and intently. All stood back, at length, and eyed me and the glass in silence for a time. An old woman broke the silence, and seemed to voice the sentiment of the rest. She was very emphatic in her language. She expressed her abhorence of what I had done. She shook her fist; her eyes flashed, but she did not swear; they cannot in Seneca; when the Indians swear they lapse into English.

Imagine my utter amazement at the turn things had taken! Her grievance was this. "It lie so! White man very bad! Make iron lie! Make glass lie! Very bad!"

I saw it all. Her senses were shocked because my magnifier "lied so," and she held me responsible.

That was my first and last attempt to teach Pagan Indians microscopical science.

THE GRAPHOLOGICAL MICROSCOPE[1].

C. M. VORCE, F. R. M. S.

AMONG the most important of the applications of the microscope to what are called "business uses" is the examination of writings, books, etc. The use of the microscope for such purposes has rapidly increased in the last ten or fifteen years, until now scarcely a case of importance whose turning point rests on the authenticity of written or printed matter, is tried without

1 Received, with the drawing, in June, 1890.

the papers or books in question being submitted to microscopical examination at the hands of experts, real or supposed. Among the points to which such examinations are applied may be mentioned the detection of forgery, alteration, erasure, interpolation, etc., the detection of the authorship of simulated or anonymous writing, the determination of relative age of different writings, identity or difference in inks, pencil marks, paper, etc.; detection of erased writings, the character of stains, marks, mutilations on paper and elsewhere.

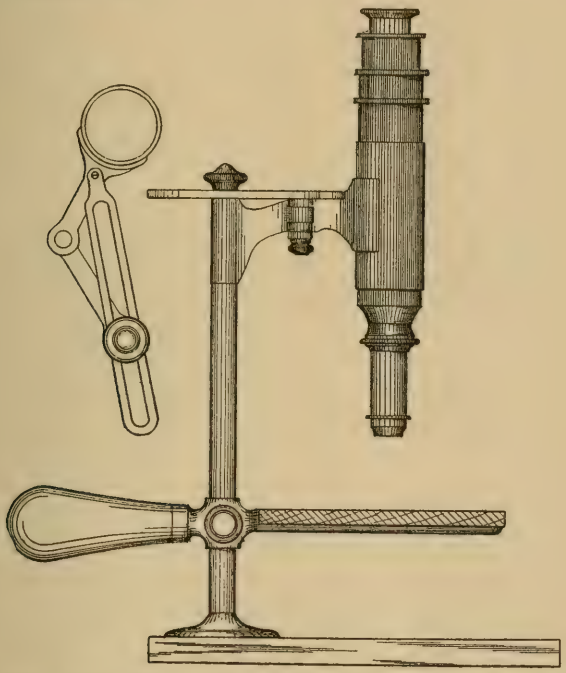
Many of the questions involved require very delicate and prolonged examination for their determination, and sometimes the use of high powers, but by far the greater number of questions involve the use of but low or medium powers, and usually the examination of considerable surfaces. Probably every microscopist who has had occasion to examine writings to any extent has felt the inconvenience of the best modern microscopes for that purpose, owing to their limited stage room and short rack. In very many cases the examination required involves the comparison of a considerable number of papers, and often of the entire surface of a good sized sheet of paper. The examination of books, such as hotel registers, Bibles, account books, etc., is almost impossible of satisfactory accomplishment with ordinary microscopes, the only way to proceed being usually to place the instrument on the book and focus through the stage-well. The "Tank Microscope" of some English makers is better for this use than any other present form, but like the others, is objectionable on account of having to be moved about over the book or paper under examination. The danger of marring or obliterating some portions of the writing to be examined often prohibits the placing of the microscope upon the writing or moving it about, and renders a satisfactory examination quite impossible.

Another serious objection to present forms of microscope for the uses of the graphologist is the inability to use them as a class microscope to be passed from hand to hand, with the objects to be viewed securely clampd in position and in focus.

To obviate the defects found in the presents microscope for such uses and to produce a form adapted to the special needs of the graphologist, as made apparent to me by some twenty years of my own experience in that line, and my observation of the work of others, I have devised the microscope stand which I

have designated The Graphological Microscope, a cut of which is here given, and which is briefly described as follow:

The pillar is a straight brass rod $\frac{5}{8}$ inch in diameter, threaded with a long screw into a plate flush with the surface of the wooden base. The stage is of wood or hard rubber, 5 by 8 inches, and rests on a forked brass plate projecting from a stout collar which slides on the pillar, and is clamped in place by a strong thumb-screw with milled head. From the back of the collar opposite the stage a strong screw projects, upon which a handle may be screwed when the instrument is to be passed about as a class microscope.



The arm is in two parts joined by a smoothly fitted joint with a nut on the pivot; the outer joint of the arm carries a slip-tube through which the body tube is focussed by sliding, and the inner joint of the arm is extended into a sleeve with a long conical bearing around the top of the pillar, ensuring a smooth motion. A flat, slotted plate is pivoted to the outer joint of the arm and rests on top of the sleeve of the inner joint, the top of the pillar passing through the slot being threaded and pivoted with

a strong thumb-nut to clamp the arm rigidly in place. By this construction the body tube may be moved about over every part of a surface six inches square, and may be clamped in place over any part of that surface by means of the thumb-nut at the top of the pillar. The papers to be examined can be arranged on the large stage and secured in place by wire clips. In case it is desired to use the instrument as a class microscope, the arm is clamped fast, the handle screwed on and the pillar unscrewed from the base plate, when the instrument can be handed about as readily as a common stereoscope, and weighing but little more.

If provision is required for the use of transmitted light, which is but seldom needed, an opening in the stage is provided, and a mirror on the base like that of a dissecting microscope. An arm for carrying a lamp may also be attached to the pillar by means of a clamping collar like that of the stage-arm, when the instrument is to be used as a class microscope at night.

It has not been found requisite to provide for inclining the instrument in use, but if desired it can readily be accomplished by providing a slotted segment on the plate into which the pillar screws, hinging this plate to an under plate secured to the base-board, with a clamp screw to clamp the segment against a projection on the fixed plate.

The instrument, as made for me by the Bausch and Lomb Optical Co., has proved very satisfactory in use, and admirably serves the purposes for which it was designed, especially in its capability of being passed from hand to hand. An entirely unpremeditated advantage has also been discovered in the ease with which objects too bulky for examination on ordinary stands, such as large minerals, natural history specimens, etc., can be laid on the base-board (the stage being loosened and swung round out of the way), and examined with this microscope over all their surface.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XV.

THE SELECTION OF THE STAND.

THESE chapters are expressions of personal preference in regard to things microscopical. The expert microscopist may

have other opinions and preferences, especially with regard to the stand to be chosen, and with the following suggestions. But these are mine.

Having decided to buy a microscope, what stand shall the beginner select? There are many of many styles, prices and degrees of excellence, but if he buys as his own ideas impel, he will probably make mistakes. In the following list of desirable stands, I have tried to mention those American instruments in the order in which I would be willing to own and personally to use them, giving my reasons for approval or criticism as far as is possible. The reader must of course remember that no objectives are here considered. They will come later. Yet most of the stands have an outfit of objectives selected by the maker, that although good of their class, will be omitted if the reader take my advice, their place being filled by others, and one at a time if necessary.

The least expensive and the least complicated stands with which any serious work may be done, are the "New Working Microscope," by Mr George Wale, and the "Student," by Messrs Bausch and Lomb. Both are built on the same plan, both are objectionable because the arm has too short a curve, thus making the space above the stage much too limited, and because the body must be extended by a draw tube to be of the standard length. The latter fault is common to all, except the best and largest stands in the market. There seems to be no help for us. The optician cuts the body in two, and at present we have no redress.

The mirror of the "Student" stand swings above the stage; in the "New Working" instrument it does not, but the latter possesses a coarse adjustment by rack and pinion, while the "Student" stand has the fine adjustment only. The "New Working Microscope" has two eye-pieces, one of which may be used to carry the micrometer. The "Student" has but one. The absence of the coarse adjustment is a fatal objection, and for that reason my choice would be the "New Working Microscope," especially since the price is somewhat less than that of the "Student." But Mr Wale's excellent instrument has not been recently offered for sale. I fear that it has been permanently withdrawn from the market, an action much to be regretted.

In the next higher grade of the less expensive commendable forms, there are two to be considered, Messrs Bausch and Lomb's "Model," and Mr Zentmayer's "American Student." So far as appearance, size, workmanship and divided body tube are concerned, there is here little to choose. Mr Zentmayer's "Student" stand has the disadvantage of costing five dollars more than the "Model," but it is, without exception, the best and most desirable of the lower grade instruments in this country, or in any other. It has coarse and fine adjustments and swinging mirror, as the "Model" also has. It possesses an abundance of room between the stage and the lower end of the arm, as the "Model" does not, the latter at that point being most inconveniently contracted. If the difference in price is important to the beginner, he may safely select the "Model," to which may be added a rotating glass stage, a luxury not applicable to the "American Student Stand," otherwise by all means take the Zentmayer.

Equally desirable with either of the two preceding stands is the "Acme No. 4" of Messrs J. W. Queen and Co. The fine adjustment screw, which is beneath the arm, the makers claim to be a great convenience, and that "it is of great delicacy and truth of motion in the axis," focussing a one-twentieth inch objective with ease and accuracy. The price is the same as that of Mr Zentmayer's "American Student."

Either of the foregoing is well adapted to the every day work of a practising physician. For urinary examinations these admirably answer, and according to my opinion, they are the least costly instruments that can be recommended for that purpose. If the physician intends to make more delicate investigations with higher powers, if he wishes to enter even a little way into Bacteriology, he must seek a stand that shall be more complete in its sub-stage arrangements than is any of these, for to none of them can a sub-stage condenser be added and this accessory is now essential for even the least advanced worker. For play it is not needed.

One or two upward steps reach Messrs Bausch and Lomb's "Investigator," and Mr Zentmeyer's "American Histological." Both are the same in price, both have the same conveniences, and both possess a centring sub-stage. The "Investigator" has a graduated circle at the summit of the mirror-bar, but if the choice were limited to these two, which should be finally selected

would not be difficult to decide. The stage of the "Investigator" can be rotated, and the mirror may be used above the object independently of the sub-stage. The former is occasionally a convenience, it is very rarely a necessity, but to have the tail-piece divided into sub-stage arm and mirror-bar is a decided advantage, and would, for me at least, turn the scale of choice in favor of the "Investigator."

With Messrs Bausch and Lomb's "Universal," and Messrs J. W. Queen and Co.'s "Acme No. 3," we may begin to notice some of the refinements and elegancies of the modern microscope. These stands are graceful, beautiful and what is better, useful. Both possess several commendable devices not offered by the preceding forms where the chief object is simplicity of design and fewness of parts. In the "Acme No. 3" the body is nearly of the standard length, the circular black glass stage bears a movable object carrier, and the mirror may be swung above it and the obliquity recorded. Its bar carries a sub-stage, with the Iris diaphragm, for which a condenser may be substituted. The sub-stage has centring adjustments, yet their form cannot be unqualifiedly commended. To the stand almost any piece of apparatus may be added, and with it the student is well armed for most any kind of microscopical work. Nearly the same description may be given of the "Universal" stand, which in some respects, notably in the stage, is simpler. It does not bear the convenient object carrier, but the upper plate rotates. The mirror-bar and the sub-stage arm are separate and graduated, the sub-stage having centring adjustments similar to those of the "Acme No. 3." The body is divided, a tube being necessary to extend it to the standard length, and even this tube carries a draw-tube. Here there is an embarrassment of tubular riches, a feature to which I object. One of my friends has this otherwise commendable stand, but one of his bad habits in connection with its use shows the tendency to which this divided body often leads. He is accustomed to incline the instrument, but with both tubes pushed in, thus leaving the body of much less than the standard length; he then obtains increased magnifying power by using a high power eye-piece. This is the perfection of microscopical laziness; as I look at him I become momentarily lost to all sublunary things except to his consummate indolence. In regard to it I have nothing further to say, for I should

fail to do the subject justice. The price of the "Universal" is somewhat less than that of the "Acme No. 3," still my choice would be the "Acme," notwithstanding the fact that the mirror-bar and the sub-stage arm are united in the tail-piece. Yet the reader can not go far wrong in selecting either.

Pressing closely upon both the "Universal" and the "Acme No. 3" comes Mr Bulloch's "Biological No. 2." It more than presses them. It surpasses both. The Acme is the lowest of the three in price and has a commendable length of body tube. In other respects it is out of the race. The "Universal," in addition to its objectionable abundance of draw tubes, has spring clips to "scalp off the cover glass," and is without means for the application of the sub-stage Abbe condenser. The only really objectionable feature about the "Biological No. 2" is its divided body tube. The stage is simple, convenient and rotating. The sub-stage arm and the mirror bar are separate, the former being movable by rack and pinion. It is adapted to the use of the sub-stage condenser and other appliances, and the whole sub-stage ring with all that it may carry, may be swung aside without disturbing the mirror. The reader can hardly appreciate this luxury unless he possesses it. I consider it one of the most convenient and most desirable additions to any stand that any optician has devised since the fine adjustment was transferred to the back of the arm. This special sub-stage is again divided into two movable parts, so that the lower ring may be swung aside with the polarising prism, thus leaving the condenser and the mirror undisturbed. These things are the most delightful of luxuries, and no other stand of moderate price has these beautiful appendages. The price is rather more than that of either the "Universal" or of the "Acme No. 3," but the stand is far superior to both. With it Mr Bulloch furnishes a Gillett or a cone diaphragm. If the microscopist shall use the sub-stage condenser these diaphragms will be useless.

A CORRESPONDNET calls my attention to the fact, that when speaking in the December number of the streaming of pro

toplasm in the onion, I should have given credit for the discovery to Professsor T. J. Burill. The error was due to an oversight, and I make the correction very cheerfully.

Other correspondents report that they have failed to see the movement of the protoplasmic current, and still others that they have not been able to observe the bands and threads that carry the granules, although the granules themselves were visible I think that we all have had the same experiences. Immediately on the receipt of my correspondents' pleasant letters I repeated the experiment, and failed utterly. Even after the onion had been all night in a warm room, not a trace of movement in the protoplasm nor among the granules could be seen. On the contrary, the colorless protoplasm was massed in little heaps and drops in the angles of the cells and along the sides of the walls, and warming in this case had no effect. Another onion that hap-ed to be sprouting, had its protoplasm in the most active movement, the motion being almost violent, the colorless material boiling along the walls, and throwing off threads and bands that bent and curved like the living things they were The granules were likewise in great agitation, while they and the outlines of the protruded threads and of the streams along the walls were plainly visible to an eighth inch homogeneous immersion objective, the particles themselves being as easily seen with a good one-fifth. The edges of the protoplasmic currents can scarcely be observed with a power less than the one-eighth, and then only by an eye somewhat accustomed to the study of minute and delicately defined objects. An Abbe condenser is a great help, but if the condenser is absent, light that is slightly oblique will make the outlines somewhat more prominent. Yet in any event, the margins are very pale and ghostly.

The phenomenon is a remarkable and an interesting one. It is easily seen after one or two trials and it calls for no complicated manipulation. A little intelligent management of the mirror, a good objective of the proper power, a little patience, and some careful attention to the smoothness of the membrane and to the absense of wrinkles, are about all that is needed for a successful view, provided the onion be alive, a fact that, unless the bulb be sprouting, can be known only after microscopic examination. The sprouting onion will probably always show the movements in its cells.

Through another correspondent, a Professor of Natural Science suggests that I have seen not the streaming of protoplasm but —osmosis!!!!

IN Bulletin No. 76 of the New Jersey Agricultural College Experiment Station, Prof Byron D. Halstead publishes important observations on "Some Fungous Diseases of the Sweet Potato," that the reader will find of interest, and of great value if he is engaged in the cultivation or even in the preservation of the roots. The pamphlet is distributed free to all that apply at the N. J. Agricultural College, New Brunswick, N. J.

ACKNOWLELGMENT.—To Dr F. A. Rogers, Brewster, Mass., for a water color drawing of blood corpuscles to illustrate his method of differential staining, to be published in THE MICROSCOPE next month.—To Mr F. E. Ives, Philadelphia, for a fine photo-micrograph of *bacillus tuberculosis* in spore, magnified 1000 diameters. —To Mr E. W. Sharp, Philadelphia, for a superb mount of the "lady bug," *Coccinella*, prepared by his carbolic acid method, also to be published in THE MICROSCOPE for March.

NEWS · FROM · THE · WORKERS ·

ACTINOSPHÆRIUM EICHHORNII[1].—In a small pond near the observatory of the State University of Iowa, I collected some material which now stands on a table in the laboratory. Minute whitish disks, plainly visible however to the unaided eye, may be seen in considerable numbers clinging to the stems and leaves of *Ceratophyllum*. An examination of these disks reveals the fact that they are gigantic Rhizopods belonging to the genus *Actinosphærium*. *A. Eichhornii* they probably are, but they are vastly larger than any individuals of this species usually seen, and larger than any recorded by Prof Leidy in his work on the "Fresh water Rhizopods of North America." The first specimen

1 S. Calvin, Bul. Biol. Lab., State Univ. Ia.

I measured, in place of being 0.4 mm, the maxium diameter given by Leidy, was 0.85 mm in diameter, with rays projecting 0.45 mm beyond the margin of the body. There are scores of individuals in my jar, and the average is in excess of 0.75 mm. The largest specimen measured had a diameter of 1.36 mm, and there are not a few individuals that seem to be equally as large.

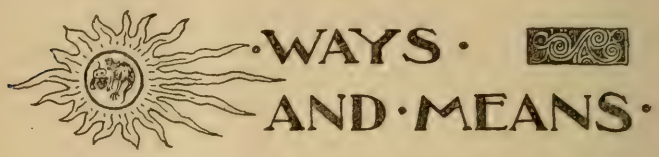
It is worthy of record that a large proportion of the specimens that passed under the microscope had been feeding on small specimens of *Cyclops*. Rotifers seem to be a favorite article of diet with *Actinosphærium*, and even the individuals that succeeded in capturing *Cyclops* contained often three of four Rotifers. *Difflugia* was taken by a few, but none so far as observed, had condescended to feed on Diatoms or other forms of Algæ. It has been a matter of surprise that a creature so sluggish as *Actinosphærium* should be able to capture *Cyclops*. How the capture is made I have thus far not been able to determine.

AMŒBOID MOVEMETS IN THE RED BLOOD CORPUSCLES OF ANÆMIC PERSONS.—Browicz (*Centralbatt für Klin. Med.*) claims to have discovered striking movements in the blood of anæmic patients. He has observed the phenomena so far in four cases: one of pernicious and one of simple anæmia, a third of septicæmia, and a fourth case of cancerous cachexia. The blood was observed in a fresh state upon a simple glass slide, and under an ordinary cover-glass. No special arrangements were needed for keeping the blood warm, as the movements would continue for hours if the preparation was not allowed to dry. A power of 600 diameters was used.

It seems that Hayem has observed similar movements, but referred them to some parastic infection of the blood, but Browicz regards them as a sort Browian movement, dependent upon some change in the chemical structure of corpuscles or plasma. That this explanation is probably correct he infers from the fact that the movements often continue for days, at an ordinary temperature, and long after the white corpuscles in the same preparation are lifeless. This he holds to be inconsistent with the known range of vital action in protoplasm.—*Journal Am. Med. Ass'n.*

A minute organism, *Bacillus subtilis*, is always associated in yeast with the fungus, *Saccharomyces cerevisiæ*, and some doubt

has recently been thrown out as to whether the fungus or the bacillus was the main agent in preparing dough for bread. Katharine Golden has made careful experiments, and has found that each separately is capable of acting on the dough; and, therefore, in an ordinary raising neither can claim exclusive credit.



A METHOD OF EMBEDDING DELICATE OBJECTS IN CELLOIDIN.

FRANK S. ABY, PH. B.

The object, properly fixed and hardened, is placed for twenty-four hours in a mixture of equal parts of alcohol and ether. It is then transferred to a thin syrupy solution of celloidin, made by dissolving celloidin in a mixture of equal parts of alcohol and ether. After remaining in this solution for about twenty-four hours, the object is covered with a thicker solution of celloidin and is allowed to remain in the same for about twenty-four hours, when it is ready to embed on cork.

When ready to embed the object, a small quantity of the celloidin solution is spread on clean glass (a slide will answer the purpose), and allowed to dry. Then another coat is applied and allowed to dry. This affords a firm celloidin bed upon which the object is placed and arranged, care being taken to place it in the desired position as quickly as possible, before the celloidin begins to harden. The whole is now covered with successive layers of the celloidin solution, until a firm support is built up for the object. When sufficiently dry, the celloidin is removed from the glass by means of a sharp knife, and if necessary, a pair of scissors is used to trim the bed to the proper size and form. It is now ready to embed on cork.

The top of a cork is coated with celloidin solution and allowed to dry. This is done to prevent air from rising from the cork and forming bubbles in the celloidin. The object, in its matrix

of hardened celloidin, is placed in the desired position on the cork, and fastened to it with celloidin. After drying in the air until a layer is formed on the outer surface firm enough to retain the shape, the cork is dropped into 50 per cent. alcohol. Usually the object is ready to cut after remaining in the alcohol one hour.

This method of preparing a bed of celloidin has been employed with very satisfactory results in obtaining sections of embryo chicks. Blastoderms of the earlier periods of incubation have been successfully sectioned. By arranging the embryo on the bed of hardened celloidin, it has been possible to get large symmetrical sections of the blastoderm. Celloidin contracts during the drying process, but by the exercise of due care in arranging the blastoderm, distortion may be avoided.

This method of embedding has given good results in studying *Hydra*, and the preparation of the celloidin bed may be resorted to in almost every case where delicate objects are to be sectioned.

AN EXPERIENCE WITH BENZOLE.

MISS M. A. BOOTH, F. R. M. S.

It may be familiar to the readers of THE MICROSCOPE, but it was new to me. I may say, by way of preface, that I have used more benzole in my work than most preparers. Possible this may have been an idiosyncracy. That no amount of painstaking will atone for poor chemicals and produce good work, is self-evident. Whether or not "get the best," is a rule for universal practice, it is an imperative necessity in microscopical work, and with no one article have I had so much trouble as with benzole. Indeed, how to obtain pure benzole suitable for microscopical work, has been to me until recently, an unsolved and unsolvable problem.

If I ordered a bottle of benzole from a dealer in microscopist's supplies, its price was doubled by expressage, and quite as likely as not the benzole was worthless. Or, if in a moment of economy, I ordered by the quantity to save expressage, quite possibly I lost both benzole and expressage, and in both cases, perhaps, after valuable time had been wasted in waiting for the dealer' stock to arrive from Europe. In this way my laboratory storeroom became a veritable infirmary.

I was discouraged, and when told that a local druggist could

furnish good benzole, faithless. But benzole I must have, and triumphantly I carried home from that druggist a bottle of beautiful, colorless benzole, a four ounce bottle for fifteen cents, as against a two ounce vial by express for fifty cents. I was elated. And best of all, I could obtain all I wanted, and at a moment's notice, with no tedious waiting for European invoices to arrive. Rising early the next morning to secure a long day's work with my new benzole, great was my disappointment to find in place of the transparent fluid which had attracted my admiring glances the evening before, a fluid which, judging from external appearances, might have been milk.

A visit to the druggist took the precedence of work. He could not explain the mystery, his benzole he knew was pure, his bottle perfectly dry, etc., and he gave me a second vial which was sure to be all right. By the time I reached home the second vial was like unto the first. "Pure benzole is a delusion," I bitterly said to myself, and deeming it useless to return the second bottle of milky fluid, I contented myself by merely telling the druggist that his benzole, like that of all the others, was worthless. Judge of my surprise when he brought out the first bottle almost brilliant in its transparency!

A wad of filtering cotton placed in the benzole in my vial had performed the miracle. Though the vial was as clean as a vial could be, there had lurked in it enough moisture to spoil the benzole, but the cotton had a sufficient affinity for the water to absorb it from the benzole. Since then I have experimented with my "infirmary" samples, and from the poorest and most discolored specimens produced faultless benzole. These wads of cotton are very useful, too, in bringing down and retaining sediment in place of filtering, in case of very volatile liquids. Put a wad into the vial and let it remain several days, then put a fresh wad to hold down the light particles which float with the slightest motion, and after a little time decant, when it will be found that the cotton has retained the sediment and color, and that a beautiful fluid results. Vials which are to hold benzole should be rinsed with alcohol to remove all traces of moisture. Wads of absorbent cotton placed in vials of discolored or turbid fluid are susceptible of considerable service in clarifying them.

GLASS DISSECTING DISHES.

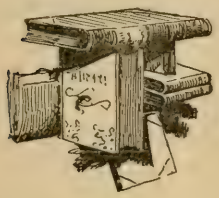
PROF CHAS. A. DAVIS.

Noticing a note in regard to dissecting dishes or trays in a recent number of THE MICROSCOPE, I have thought that it might interest some of the workers to know how I make a very serviceable and cheap form. I bought some of the glass candy trays which are used by grocers and others to display candy. These cost about the same as tin dishes of the same size and are more durable, let the light through the sides and can be cleaned thoroughly. These can be bought of any grocer, and come in various sizes. Instead of cork for the bottom I use wax, a mixture of paraffin and beeswax colored with lamp-black. I have never tried either alone, but mixed them because I had both, and thought the beeswax would toughen the paraffin, which it does admirably. In order to keep the wax from floating I put a layer of No. 6 bird shot in the bottom of the dish and turn the hot wax on to it, stiring it in order to cover the shot well and to keep the lamp-black from separating from the wax. The advantage of wax over cork is great, I think, for it can be renewed when dirty or full of pinholes, by simply putting the dish on the top of a steam radiator or a moderately warm stove for a short time, stiring the wax and allowing it to cool again.

For finer or smaller work I use a glass sauce dish. I find that common white porcelain butter-plates make very nice "watch glasses," or rather a subtitute for them, as they furnish a good ground on which to see specimens, particularly at night. I use them almost exclusively and like them very much; they are also cheap.

APPARATUS FOR DRAWING MINUTE OBJECTS.—An ingenious device for drawing small objects was some time ago invented by Fritsch of Vienna, and has been found of valuable application in the interests of naturalists. The instrument is intended to throw an enlarged image of the object upon the table to admit of its being copied. It consists of a concave mirror of about two and one-half inches in diameter, movably attached to the summit of a metal or other kind of upright rod. Below it is a movable stage to bear the object and with a central opening to allow the passage of the light from the mirror. Beneath the stage is a movable rod bearing at its extremity a ring to receive

the magnifying lens, and under it a cone of paper with the small upper end cut off. This cone stands over a large opening in a box from which the front has been removed. When in use the apparatus is placed near the lamp flame in such a manner that the mirror reflects the light through the object, the lens and the hollow cone, into the box and upon a sheet of paper placed on the table beneath the central opening. The image thus thrown down can be easily copied by the artist line for line. The apparatus is so simple that anyone can make it out of wood and paste-board, if he can command a concave mirror and a good lens.



NEW PUBLICATIONS

CHEMICAL LECTURE NOTES. By H. M. Whelpley, M. D. Third edition. Illustrated. 12mo., pp. 211. St. Louis, Mo. Price $1.50.—This little book, while it is primarily intended as a help to the college student in refreshing his memory of the lecture course, should be a useful one for any reader to have within reach at any moment, as it contains much that is often needed by every educated and observing person. The best trained memory is treacherous and needs a hint to be able to recall its information, a word sometimes being sufficient. This small book should be helpful to those who, like the school boy, know but can't think. Its statements are in an exceedingly concise form, a single word often answering the purpose of a sentence to the lecturer or to the college student, and capable of doing the same to those who have been through a similar course of lectures or of reading. While it is devoted to chemistry chiefly it does not neglect what is called physics, or what at one time was styled natural philosophy. The microscopist will find some interesting and suggestive matter in the twenty-two pages devoted to the study of light. The medical reader who wishes to polish up his chemical knowledge will find the book a convenient means of accomplishing that object.

OUTLINES OF HISTOLOGICAL TECHNOLOGY. By Frank S. Aby, Ph. B., Instructor in Biology, State University of Iowa. 16mo., pp. 80. Iowa City: A. J. Hershire and Co.—This little book, the author says, is intended for the use of the students in his class. He has therefore presented briefly only a few fundamental methods, selecting those that he is in the habit of recommending, and confining his attention to one or two only under each section, mentioning but three stains out of the almost innumerable array of reagents. Special attention is paid to the bibliography of histological methods, references being given under each head, with blank space left to be filled by the pupil if additional references are needed. Space for remarks and notes is also provided. The author treats of injecting, hardening, embedding, sectioning, staining, clearing, and mounting.

THE UNIVERSITY MAGAZINE.—New York. From Ephraim Cutter.

PARLIAMENTARY TACTICS, OR RULES OF ORDER.—By W. B. Grubbes, Jr.

GRAY MEMORIAL BOTANICAL CHAPTER OF THE AGASSIZ ASSOCIATION.

BULLETIN NO. 9, OF THE EXPERIMENT STATION OF FLORIDA, April, 1890.

FIFTH ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF THE STATE OF MAINE, 1889.

MISSOURI AGRICULTURAL EXPERIMENT STATION, BUL. No. 11. Texas Fever.—By Paul Paquin.

RUSTS, SMUTS, ERGOTS and ROTS.—Dr B. D. Halstead. Reprint.

NOTES UPON THE STAMENS OF SOLANACEÆ.—Dr B. D Halstead. Reprint.

FRESH WATER SPONGES OF CANADA AND NEWFOUNDLAND.—A. H. MacKay. Reprint.

EDITOR THE MICROSCOPE:—

I enclose a drawing of a useful device for centring slides and covers in mounting. Please print it on an advertisement page from which it may be cut and pasted on a piece of wood, with the ends and one side enclosed by small strips of wood, against which the slide can be held while mounting.

Yours truly,

HIGHLAND FALLS, N. Y. ALFRED PELL.

[The illustration of Mr Pell's device will be found inserted in the advertisement pages.]

EDITOR THE MICROSCOPE:—

I have some phials of Diatoms which were originally in distilled water. The water has evaporated through the cork so that the Diatoms have dried on the sides of the phial as a film which clings persistently and refuses to be loosened. I have filled up with water, also with alcohol, but several days' action appears to make no impression. I am afraid to scrape for fear of crushing the valves. What procedure would you advise?

I have another puzzling case. I possess some insect dissections that have been in phials of turpentine for two or three years, and by evaporation through the cork the turpentine has thickened, grown whitish and resinous, and has finally deposited a whitish substance (probably resinous in its nature) on the insect parts so as to spoil them for mounting purposes. I have tried soaking them in turpentine and benzole but do not succeed in cleaning them. Have you ever had a like experience? and what would you suggest? Yours very truly,

ROOM 5, CENTRAL UNION DEPOT, EDWIN A. HILL.
CINCINNATI, O.

THE MICROSCOPE

AN ILLUSTRATED MONTHLY MAGAZINE.

VOL. XI. TRENTON, N. J., MARCH, 1891. No. 3.

ORIGINAL COMMUNICATIONS

CYTOLOGY OR CELLULAR BIOLOGY.—III.

DISCOVERY OF THE CELL AND ITS CONSTITUENT PARTS.—ELEMENTARY ORGANISMS.—THE CELLULAR THEORY.

REV A. M. KIRSCH, C. S. C., PROFESSOR OF BIOLOGY, UNIVERSITY OF NOTRE DAME.

IN all scientific investigations it is necessary first to know what has already been done in the department in the past; in other words, one must be familiar with the bibliography of the subject under consideration. An investigator that does not observe this rule will often lose much valuable time in going over the same ground that another has already explored. It is not my object at present to publish original observations and investigations in Cytology, for I fear that many of my readers are not yet acquainted with this line of investigation. The reader will therefore kindly excuse me for presuming to take upon myself the office of a cicerone.

As far as I know, there exists only one text-book of Cytology, that by Canon J. B. Carnoy, Professor of Cytology in the University of Louvain; even this is not yet completed. Professor Carnoy, therefore, must serve as a guide to introduce my readers to a knowledge of the subject. I deem it also necessary to ac-

knowledge my great indebtedness to Prof Carnoy for his kindness in placing at my disposal much valuable material for my readers' benefit. In justice, I must also state that I cannot aim at originality, but must often content myself with being only Canon Carnoy's mouth-piece. If I were to try to give a better history of the cell than that given in his "Biology Cellulaire" I must surely fail, and therefore the reader will forgive me when I draw largely from that source.

I.—DISCOVERY OF THE CELL AND ITS PARTS.

The history of the cell begins about the middle of the 17th century (1665), fifteen years after the invention of the microscope. Robert Hooke was the first to call attention to the cellular structure of plants. He makes use of the terms "cell" and "pore," and compares the structure of plants to that of a honeycomb. In his Micrographia, 1665, he says: "Our microscope informs us that the substance of cork is altogether fill'd with air, and that that air is perfectly enclosed in little boxes, or cells, distinct from one another." But to Marcello Malpighi and Nehemia Grew[2] we must give the honor of having shown the importance of these organic elements, and for having disclosed to men of science the true nature of the cell as known at the time. According to Malpighi's idea, these elements are closed "utricles," placed side by side, in order to constitute the entire body of the plant. Grew and Leeuwenhoeck call them "vesicles," and the latter in a letter to the Royal Society of London makes mention also of the cell membrane. A few scientists like Wolff and Mirbel were of the opinion that cells are only simple cavities, formed in the fundamental and independent mass; otherwise we find it, however, generally admitted, from the time of Malpighi and Leeuwenhoek till Leydig (1856), that the cells are endowed with a solid and distinct wall proper to them, that they are therefore true particles in juxtaposition. Leydig modified this view as we shall see. The terms "utricle" introduced by Malpighi, Grew and Leeuwenhoek, were in use till the time of Brisseau Mirbel, who reintroduced the term "cell" which had been first given to these elements of living bodies by Hooke in 1665. This term although erroneous according to the present state of knowledge is now universally used.

2 In his Anatomy of Plants (Book I. page 4), 1671, Grew says: "It is a body very curiously organized, consisting of an infinite number of very small bladders," etc.

For more than a century, cells were regarded as vesicles containing a homogeneous liquid. But in 1781 Fontana discovered the nucleus, which he illustrates with its nucleolus, and in his second volume, he describes the nucleus as "an ovoid body, provided with a spot in its centre." Moreover, in various places he speaks of the granular contents of the cells, and clearly represents by figures adipose cells with their numerous fat globules.

About this time were also made the first experiments in microchemistry, as stated by Baker. Fontana employed acids and alkalies and even vegetable colors, and Meyen in 1828, enumerates a series of bodies, such as starch, chlorophyll bodies, crystals, etc., as having been found in vegetable cells. The works of Meyen are interesting as they give a summary of what has been done in micro-chemistry during the past period. In 1831, R. Brown greatly advanced the knowledge of the cell by confirming and extending considerably the researches and discoveries of Fontana; but his merit consists, not so much in having discovered the nucleus, as in having recognized it as a normal element of the cell.

Almost at the same time, Mirbel, in his "Researches on the Marchantia" (1831–32), mentions the nucleus and calls it "spherule." Finally, the researches of Meyen, Schleiden, Unger, Schwann and Nægeli completely demonstrate that the nucleus must be regarded as an essential element in the cell, and that it may be found in the majority of both animal and vegetable cells. Schleiden in 1838 calls the nucleus "cytoblast," and attributes to it a special function in the formation of cells. Later on, Martin Barry and John Goodsir contended that the reproduction and multiplication of cells were due to self-division of the nucleus, and thus gave greater importance to the nucleus than had previously been assigned to it.

As early as 1781, Fontana, had mentioned the nucleolus, but Valentine was the first to illustrate it by a figure in his "Repertorium." He speaks of the nucleolus as a small, round corpuscle, "a kind of second nucleus" in the interior of the nucleus.

According to Schleiden, the nucleolus is a sort of kernel, "kernchen," and Schwann, calls it "Kernkorperchen;" finally, in the same year, 1839, Valentine uses at the same time the terms nucleolus, and "Kernkorperchen," and these two terms are still in use.

Thus we have seen how the cell and its various parts were gradually discovered, and at the close of this epoch, the cell could be defined as "A vesicle surrounded by a solid membrane, containing a fluid in which floats a nucleus provided with a nucleolus, and in which may be seen bodies of various forms."

II. CELLS AS INDEPENDENT INDIVIDUALITIES.

At the present day, many naturalists regard the cell as an independant individuality, a sort of elementary organism. This notion finds expression for the first time in the work of Turpin, as may be seen even on his title-page: "Observations on Every Vesicle Composing Cellular Tissue, Considered as so Many *Distinct Individualities*, Having their Special Vital Centre of Vegetation and Propagation, and Destined to Form, by Agglomeration, *Compound* Individualities in all those Vegetables in which the Organization of the Mass Implies more than one Vesicle."

Mirbel and Schleiden express themselves no less explicitly. The former says: "Cells are so many living individuals, endowed within certain limits, with the properties of growth, multiplication and modification. . . A plant, therefore, is a collective being;" and Schleiden admits that "the cell is a small organism," that "every plant, even the highest, is but an aggregate of cells completely individualized and distinct in their existence." Schwann and Hæckel also accept this idea, but others, as Julius Sachs, reject it. This subject will be treated hereafter at greater length.

III. CELLULAR THEORY.

Whilst studying the parts of the cell, the scientists were obliged to look for examples among organized bodies; they could therefore scarcely avoid the studying also of the internal structure of plants and animals. Thus Malpighi, Grew and Leeuwenhoek, relying on their researches and observations, affirm with the greatest confidence, that the body of a plant is entirely formed of cells in juxtaposition, and the researches of Brisseau Mirbel, of Meyen, of Schleiden, and especially the important memoirs of Hugo von Mohl, published since 1827, completely confirm this statement of Malpighi, Grew and Leeuwenhoek, and at the same time prove that all vegetable tissues, no matter how much they may have become differentiated, are exclusively formed from cells, which are derived one from another, and which have the same genetic origin, although they may have undergone a

complete metamorphosis whilst passing through their evolutions.

Turpin also says that; a "tree, like every other organized being, begins its existence in the form of a single globule, or mother-vesicle." From this we are led to conclude that even before 1830 the cellular theory had already been formulated and established, at least with reference to plants.

During all this time zoologists had not kept pace with the botanists. It is true, however, that now and then the analogy between the two kingdoms of Nature had been pointed out, and even striking resemblances had been observed; but in reality, Dutrochet in 1824, was the first to promote the idea that animals and vegetables are organized on the same plan; that both develop in the same way, and finally that in animals also all tissues are composed of cells. He says: "It is evident that all organic tissues of vegetables are derived from the cell, and observation now proves the fact that the same holds good for animals. . . . All the tissues, all organs of animals, are really nothing else but cellular tissue variously modified."

Although Dutrochet has not been succesful in proving his thesis (his descriptions, at least with regard to animals, are often inexact and erroneous), it remains nevertheless true that he was the first author to apply the cellular theory to animals.

To Schwann, a disciple of Schleiden, belongs the honor of furnishing the proofs and demonstrations for the thesis of Dutrochet; and this he has done in a most brilliant manner in a memoir which marks an epoch in the annals of Cellular Biology. In this memoir Schwann takes up one tissue after another, and basing his arguments on a great number of most rigorous and most accurate observations, he establishes forever the fundamental doctrines of the "Cellular Theory," which may be summed up in the following statements: 1st. All animals and plants are exclusively formed of cells. 2d. All these cells are derived one from another, beginning with the embryonic cells. 3d. Owing to their natural evolution, these cells undergo more or less marked modification before they arrive at that state which they present in the adult tissues.

We find a good summary of the researches of Schwann in Valentin's "Repertorium," (1839), where we also find the name "Cellular Theory."

John Goodsir in 1845, and later on also Virchow, applied this

theory to pathology. But as first announced by Schwann, the theory has been variously modified owing to further researches in embryology, histology, and especially in cell-multiplication and the formation of multinucleated cells. (In the first paper of this series Hooke is said to have discovered the cell in 1865; it should have read 1665.)

CARBON DYES.

PROFESSOR WILLIAM H. SEAMAN.

THE scientific conception of color is a wave of a certain definite length in the cosmic ether. The name is also given to any substance that has the property of reflecting or transmitting particular waves, and can be applied in any way to a surface to which it gives its own color.

Substances of the latter class are of two kinds, those which must be stuck on or fastened by some adhesive cement to the surface to which they are applied, and those which soak into and saturate the material. The first are usually insoluble powders, known as pigments, and the latter are soluble in a medium such as water, alcohol, or benzene, and are called dyes. The latter also combine chemically more or less with the substances to which they are applied.

Previous to 1856 the latter were mostly of vegetable origin, as logwood, fustic, quercitron, etc. In that year Perkins' violet was put on the market, the first dye commercially successful that was made from anilin, the latter substance being obtained indirectly from coal tar, which has also furnished the raw material for many other colors, often called generically, coal tar colors.

These substances have proved superior in every respect as dyes to any others known, and hence will in a short time be the only dyes in use. The popular idea, that they are fugitive, is based on some of the first, and is not true. They differ among themselves, just as do the older dyes, in this respect, but many are the fastest colors known. Excepting carbon black, every color is modified by long exposure to light, moisture, and warmth[1].

It is impossible to give any correct ideas about carbon dyes without some reference to their chemical relations, because they

1 De Abney. Sci. Am. Supplement, No. 689-690. Light and color. Report British Ass'n 1888. A. Richardson. Permanence of colors.

are especially the children of modern chemistry. Like organic substances, they consist mostly of charcoal or carbon, C; oxygen, O; hydrogen, H; and nitrogen, N, with in some cases small quanties of sulphur, chlorine, or other element. The variety of elements in their composition being so small, their properties are due to variation in the number and peculiar grouping of the atoms around a central nucleus of carbon.

According to Giercke[2], Waldeyer was the first to employ these dyes in microscopy, but he says they have not yet found favor.

This statement is no longer true, they are essential in bacteriological work, and also in double staining, in which they achieved their first success.

Slight changes in the methods of manufacture often make differences of shade which are denoted by letters as BB, BBB, or 4B, the latter indicating a deeper shade, or as scarlet G, (gelb) orange.

Most of our supply comes from Germany, but several kinds are now made in this country. Nearly every dye is protected by patents and made by a single firm.

The chemical name of these substances expresses their composition according to chemical rules, but as the name increases in length with complexity of composition, those much in use often acquire trade names, that vary with the fancy of the maker. Thus Bismark brown, vesuvin, anilin brown, leather brown, Manchester brown, etc., are trade names of the dye known to chemists as Triamido-azo-benzene chloride, C_{12} H_{15} N_5 Cl_2. Chrysoidin is Diamido-azo-benzene chloride, C_{12} H_{13} N_4 Cl.

From a practical standpoint, they are divided in two classes, those which dye without mordants, or substantive colors, and those which require some fixing agent, as chrome alum or acetic acid, known as adjective colors. The substantive colors are best adapted for the microscopist.

The earlier colors had much more affinity for animal matter than for vegetable, and hence were not well adapted for plant work. The number of substantive dyes has lately been much increased by additions to the class of azo dyes, adapted to unite with cellulose without any mordant, and extremely fast to light, etc.

Among these especially to be recommended for the microscop-

2 Giercke, 262 methods of staining. Am. Monthly Micros. Journ. 1885-1886.

ist are the Benzidin colors as Congo red, of which there are several kinds made by combining with Benzidin, $C_{12}\ H_8\ (NH_2)_2$, various sulphonated phenol derivatives.

Many of these dye directly, otherwise with a little alkali, giving some shade of red, which changes to blue by the addition of a weak acid.

Eosine may almost be regarded as the name of a class of dyes, so many varieties are called by this title, alone or in combination. They are derived from fluorescein, $C_2\ O\ H_{12}\ O_5$, which is one of the most intense coloring substances known, though not fast. It is said that one part in 2,000,000 in water may be readily observed. This enables it to be used to detect leaks in pipes, etc.

Its derivatives made with haloids and alcohol radicals, are much used in microscopical work. As with other popular dyes, it is impossible to specify the characters of any particular specimen, unless the maker's name and exact trade name are known. Perkins' violet, Mauvein, Rosein, Anilin violet, Mauve, Purpurin, Phenamine, Tyraline are a few of the names of the first of the carbon colors that came into commerce, obtained by the oxidation of commercial anilin. It is not so much used as formerly, but is the main ingredient of the inks used for rubber stamps.

Alizarin chemically is different from the preceeding, being derived from anthracene, and forms the base of a great variety of colors, according to the mordant used, from yellow through red to black. Anilin blue, soluble blue, Nicholson's blue, and methyl blue are compounds of tri-phenyl rosanilin, and in some cases admit of direct dyeing.

It is impossible to classify these substances so that the general reader will obtain any information therefrom. The chemist looks upon them as derived from anilin and its homologues, phenol or carbolic acid, alizarin, etc, while the dyer considers them as different kinds of a color, as alizarin blue, crocein scarlet, etc., But the same article may be produced by different processes of manufacture, and the same color by dyes entirely different in other characters, as fastness to light, soap, etc.

As every one is produced by some peculiar chemical process, first described in some journal, or in a patent, it has become customary in technical literature, to identify them by the number of the patent, or the book where first described, and this is the most certain and shortest way of doing it.

It is thus impossible to do justice to the subject in a magazine article, and those who desire further information, will find it in the following works, of which the first two will be found most generally useful.

The chemistry of coal tar colors, Benedikt and Knecht; London: George Bell and Sons, 1886. Organic Analysis, by Albert B. Prescott. New York: D. Van Nostrand 1887. Commercial Organic Analysis, by Alfred H. Allen. Vol. III. J. and A. Churchill, London, Eng., 1889. Tabellarische Uebersicht der kunstlichen organischen Farbstoffe, Schultz and Julius; R. Gaertner, Berlin, 1888. Fortschritte der Theerfarbenfabricatiou und verwandter Industriezweige, 1877-1887, Dr P. Friedlander; Julius Springer, Berlin, 1888. Handbuch der organischen Chemie, Dr F. Beilstein; Leopold Voss, Hamburg and Leipzig, Zweite Ausgabe, 1887.

SOME EXPERIMENTS TO DETERMINE THF LIMIT OF VISION AS RELATED TO THE SIZE OF THE OBJECT OBSERVED.[1]

PROFESSOR M. D. EWELL, M. D., LL. D.

IN Vol. I of Tiddy's Legal Medicine, page 248, we find the following statements:

"With respect to the smallest objects recognizable by the unassisted sight, there has been much difference of opinion. Carpenter states (apparently on the authority of Ehrenberg), that the smallest square magnitude, black or white, which can be seen on a ground of the reverse color, is about the $\frac{1}{400}$ to the $\frac{1}{340}$ of an inch, whilst particles that powerfully reflect light, such as gold dust of the $\frac{1}{1125}$ of an inch, can be seen with the naked eye in common daylight. Bergman found that black and white checkers of $\frac{1}{25}$ an inch square could be discerned at such distance that the retinal image of each square could not have exceeded half the diameter of one the cones of the bacillary layer, which are said to have a diameter of $\frac{1}{1166}$ of an inch[2]. Dr Vincent de Guéret (of Creuse) in 'La France Medicale,' (No. 57 for 1875,) states that objects to be seen at all must have a diameter of the $\frac{1}{6250}$ of an inch.

"*Lines* are more easily perceived than *points*. Thus opaque threads of the $\frac{1}{4900}$ of an inch (*i. e.* about half the diameter of a silk worm's fibre) can be discerned by most people with the naked eye when held towards the light[3]. Volkmann (quoted in

1 Read before the Am. Soc. Microscopists.
2 This compounds to a distance of 27.77 from the eye.

Funke's 'Lehrbuch d Physiologie') considered that parallel black lines could be seen when the $\frac{1}{1000}$ of a millimetre apart ($\frac{1}{62\frac{1}{50}}$ of an inch)."

"Passing from microscopic objects, we note that at a distance of one foot a person with normal sight can scarcely see any object less than one-twenty-fifth of an inch. At greater distances the size must increase comparatively."

This statement seems so much opposed to my experience that I have submitted the following described tests to nineteen different persons of ages ranging from seventeen to upwards of fifty with the results given in the accompanying table.

No. 1. consisted of a piece of black paper approximately one mm. (one-twenty-fifth inch) square pasted upon a white back-ground. No. 2. consisted of a similar white square upon a black back-ground. No. 3. consisted of a black line approximately one mm. broad upon a white back-ground. To be exact the dimensions of No. I. were 1.08 mm x 1.04 mm; No. II. 1.08 mm x 1.98 mm. No. III. 1.12 mm in width.

The manner of making the tests was to hang the cards in a good light, not artificial, and approach them from such a distance that they were invisible, and note the respective distance at which they became visible, and at which the shape of the squares could first be defined.

The accompanying table gives the results of several tests: The first column gives the age, the second the condition of eyes when known, the third the distance in feet and inches at which the black square first became visible, the fourth the distance at which the black square could be defined, the fifth and sixth give the same particulars as to the white square, and the seventh gives the distance at which the line first became visible.

A large number of other tests were made with another set of cards, but unfortunately one of the students lost them before they had been measured, so that the results are not in the table. There are however, a sufficient number of observations to show pretty nearly the average limit of normal vision and to demonstrate the gross inaccuracy of the above quotation from Dr Tidy's work.

3 In the experience of the writer, lines very much smaller can be readily made out by the average eye. A line ruled on glass or metal, which is less than 1/μ in diameter is distinctly visible. Professor Rogers states that he has seen lines one one hundred and fifty thousandth inch in diameter, and this with the unaided eye. Diffraction undoubtedly has much to do with this result.

TABLE OF OBSERVATIONS.

AGE.	EYES.	Black ■ No. I., VISIBLE	Black ■ No. I., DEFINED	White [] No. II., VISIBLE	White [] No. II., DEFINED	Black —— No. III., VISIBLE
23	Normal.	19′—3″	4′—6″	13′—2″	4′—1″	
22	"	19 7	4 6	28 1	5 6	69′—8″
17	"	28 0	12 3	27 0		64 6
21	"	23 0	5 0	25 0	12 0	80 0
23	"	24 0	9 0	28 0	10 0	90 0
24	"	28 0	5 0	21 0	6 0	75 0
23	"	27 0	4 6	24 0	7 0	69 0
21	"	24 6	5 3	24 4	5 0	
23	"	26 8	5 9	23 11	4 9	60 0
25	"	34 0	6 0	26 6	4 6	62 0
24	"	23 9	4 9	24 0	5 1	98 3
26	"	26 0	5 8	15 6	3 10	108 0
	"	25 2	5 10	24 2	4 11	63 0
20	"	21 3	5 3	17 1	4 4	48 6
	"	20 9	5 3	16 6	5 3	
	"	23 9	2 8	16 3	3 2	
	"	36 0	5 11	28 9	5 6	
42	"	29 0	5 2	24 0	4 6	78 7
22	Hyp'etropic. One dioptric "	31 0	8 0	27 0	27 0	83 0
Mean distance.....		26—4	5—10	22—11	5—7	75—0

1. Room not very well lighted. 2. Corrected by glasses. 3. This is clearly an error, though it was so reported.

Referring to the preceding table it will be noticed that in 16 out of 19 observations of No. 1 and No. 2, No. 1 was visible at a greater distance than No. 2; and in three cases No. 2 was visible at a greater distance than No. 1. It will also be noticed with reference to No. 1 and No. 2 that in nine cases out of eighteen observations No. 1 was defined at a greater distance than No. 2; in eight cases No. 2 was defined at a greater distance than No.1, and in one case they were defined at the same distance. The mean distance, 26 feet and 4 inches at which No. 1 was visible, corresponds to a visual angle of 26.1 seconds of arc, while the mean distance, 22 feet and 11 inches at which No. 2 was visible, corresponds to 30.0 seconds of arc. The mean distance, 5 feet and 10 inches at which No. 1 was defined, corresponds to 57″ of arc; while the mean distance, 5 feet and 7 inches at which No. 2 was defined corresponds to 2′-3″.1 of arc. The mean distance, 75 feet at which No. 3 was visible, corresponds to 9″.2 of arc.

The results found by Bergmann, recorded in the foregoing quotation, correspond to a distance of 27.77 feet, which correspond, as closely as could be expected perhaps with the results in the table as respects No. 1. From the table the following deductions may be made: At a distance of 10 inches from the eye a black square on a white back ground in order to be visible must have a dimension of at least $\frac{1}{790}$ of an inch square, that is, the angle subtended by a square $\frac{1}{25}$ of an inch on a side at a distance of 26 feet and 4 inches, is the same as that subtended by a square $\frac{1}{790}$ of an inch on each side at a distance of 10 inches. With a tube-length of 10 inches and an amplification of 500 diameters the smallest black square on a white back-ground that can be seen must be at least $\frac{1}{39500}$ of an inch square; and under the same conditions the smallest square that can be defined must be at least $\frac{1}{87500}$ inch on a side.

With the same tube-length, and with an amplification of 1000 diameters, the smallest similar object visible must be at least $\frac{1}{790000}$ of an inch square. With unaided vision the same object in order to be defined at a distance of 10 inches from the eye must be at least $\frac{1}{175}$ of an inch square. With a tube-length of 10 inches and an amplification of 1000 diameters, the smallest similar object in order that it can be defined must be at least $\frac{1}{175000}$ of an inch square.

These results are the mean of all the above recorded observations. The results arrived at by the writer vary somewhat from the above mean. At 10 inches the smallest black square on a white back-ground that is visible to the writer must be at least $\frac{1}{8700}$ of an inch square; and the smallest that can be defined with an amplification of 500 diameters the smallest similar object visible would be $\frac{1}{43500}$ inch square, and the smallest defined $\frac{1}{7750}$ inch. With an amplification of 100 diameters the smallest square visible would be $\frac{1}{870000}$ inch on each side, and the smallest defined $\frac{1}{155000}$ inch on a side.

With an amplification of 1500 diameters and the same tube-length, the smallest object that is visible to the writer would be at least $\frac{1}{130500}$ of an inch square, and the smallest that can be defined under the same conditions must be at least $\frac{1}{23250}$ of an inch square. It will be observed that with a whole square on a black back-ground contrary to what might be supposed the links of visibility and of definition are not so small.

It may, perhaps, be objected that the foregoing deductions can not properly be made for the reason that the conditions of microscopic vision are entirely different from those of ordinary vision. The writer is fully sensible of the force of these objections; nevertheless the mechanical difficulties in the way of manufacturing a similar test object of a definite size so small as those above are so great as to be insuperable, and the writer knows of no other way of arriving at the conclusions here drawn unless it be actually to measure the smallest point visible under the microscope with different powers. It was the intention of the writer to include in this paper the results of such measurements; but the want of time has prevented the accomplishment of this work, the results of which must be reserved for a future communication. There are, however, so many sources of error in the measurments of such minute objects that, as it seems to the writer, the errors in the results would be quite as great, if not greater, than in the results here recorded. Whereas in the latter the object observed is so large as to present no mechanical difficulties in its manufacture. No reference is made in the foregoing observations to the resolution of finely ruled lines but only to the objects described. It is quite likely that a different combination of colors, would be followed by different results but this must be left for future observation.

REFRACTIVE INDEX AND MOUNTING MEDIA.

PROFESSOR A. B. AUBERT.

JUDGING from the communications occasionally seen in microscopical journals on the subject of increasing the refractive index of mounting media, I am inclined to think that a misconception exists in the minds of some as to the methods by which this end can be attained. Thus, for instance, one writer indicates the possibility of treating some of the oils and resinous media with lead chromate, expecting thereby, I suppose, to increase their refractive indices. Such, however, would only be the case if the lead chromate were soluble in these media.

The easiest method of obtaining highly refractive media, is to dissolve a highly refractive substance in a highly refractive solvent, which will not act chemically, but produce a solution of the requisite consistency.

The refractive index of such a solution can be very approximately calculated when the indices of solid and solvent, and the relative quantities of each are known.

The laws that govern the refractive indices of chemical compounds are not yet well known, so that in most cases it is difficult to foretell the probable index of a given combination, the indices of the elements being known. In some of the organic series, however, considerable progress has been made in this line of investigation.

Of the ordinary highly refractive media monobrom balsam, purified American styrax, and probably Weir's monobrom tolu will prove the most satisfactory. Monobrom balsam owes its increased index to the monobrom-naphthalin in which the balsam is dissolved. The gum of *Liquidamber styraciflua*, or American styrax, is a resin of high refractive index, chloroform or benzol being used to reduce it to proper fluidity. In Weir's medium we have a highly refractive resin dissolved in a highly refractive solvent.

In preparing media of a resinous nature such as styrax, balsam of tolu, etc., great care should be taken to purify them thoroughly so as to extract all products which might separate out in time and render the mount granular or crystalline. The other media having high refractive indices, such as solution of potassio-mercuric iodide, monobrom-naphthalin, solution of phosphorus in carbon disulphide, etc., are either difficult to seal properly, dangerous to manage or otherwise unsatisfactory.

Many of the so-called chemical media containing bromine, arsenic, sulphur, chloride of tin, bromide of antimony, etc., are all liable to become granular or crystalline in time, though owing to their high refractive index they give very brilliant effects, while they remain clear.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XVI.

THE SELECTION, CARE AND USE OF A STAND.

ON only a slightly lower plane than the best two stands in the world, the "Congress" of W. H. Bulloch, and the "American Centennial" of Joseph Zentmayer, are Mr Zentmayer's "New

Model United States Hospital" and Messrs Baush and Lomb's "Professional." Both are beautiful instruments, and with either any microscopist should be contented. Any reader capable of using either of these stands to the best purpose is capable of making an intelligent selection. His knowledge of the good and the best would lead him aright.

The same words apply even more strongly to the "Congress" and the "Professional" of Mr Bulloch and to the "American Centennial" of Mr Zentmayer. All are magnificent, each is beautiful, but even here there is a choice; one being perfectly adapted to work that the others may do less readily. Any expression of preference on my part would be unnecessary, for each is as nearly perfect as the human brains and hands of its designer can make it. Which is better adapted to the needs of the purchaser, that purchaser must decide for himself. These instruments are the best in the world.

All the foregoing are American stands. The reader should not get the idea that the writer is in a permanently critical mood concerning British microscopes, as he is in regard to invertebrate French and German instruments. That is not the case. The majority of British stands are excellent. Their workmanship is good, their design commendable, and their utility as great as that of American models. But they are no better in any of these particulars. Then why should the microscopist travel thousands of miles for what he can obtain of equal excellence at his own door? I can see no good reason in such a journey for such an object, and my advice would be that he stay at home, unless he desire to travel in that beautiful country to widen his mental horizon, to expend his mind, and to obtain such a liberal education as no college can give him, and no library store up for his use.

When the microscope is received from the dealer it will be in a case, with a lock and key which are often mentioned in the catalogues as if they were rare and unfamiliar things. After the box has been lifted to the table by the brass handle at the top, the door is opened, and the owner glances within, his heart beating a little faster, and pleasant anticipations bringing a pleasant expression to his face. The instrument will probably have the front toward the back of the case, therefore turned away from the microscopist. At first acquaintance it will turn its back on you in more senses than one.

I have seen men clutch the upright stand by the body and the milled heads of the coarse adjustment, drag out the unresisting thing and set it down on the table with a bang. Such men are not fit to possess a microscope. The instrument may be strong and well made, but as some one has said, it is never necessary to brutalize it. If it be supplied with a base board as it should be, gently slide it out of the case by pulling board and all toward you, and as gently place it on the table. If it be not attached in any way to the case, carefully lift it out by means of the arm. If you treat the instrument kindly it will repay you a thousand fold. If you attempt to coerce it, a rebellion will be speedy and your downfall sure.

Sometimes one eye-piece will be found in the body tube, sometimes in a side box or drawer, according to the size and style of the case and the stand. In any event the eye-piece is to be gently dropped into the top of the body tube as the stand rests vertically on the table. The microscopist seats himself on a chair and in any position that he may find comfortable. Every observer will form habits of his own in reference to his position before the instrument, and will have his own ideas as to the proper size and style of his work table, and perhaps even to the number of legs that the table should have. Some writers have advised that there shall be three legs to the microscopical table so that it may be steady on an uneven surface. There is no objection to three legs, if the microscopist wants them. He may also sit on a three legged stool, if he should desire to do so. But since the floors of modern houses are seldom uneven enough to disturb the equinimity of a quadrupedal table, that seems to be the preferable form, the great desiderata being firmness and solidity. I remember that the ladies in my family were once attacked by the æsthetic notion that if I could be induced to put the microscope on what they called a "Tea-poy" table, and under a glass shade, it would look well. The table had four filamentous legs, and a shelf half way between the floor and the top, the whole being a silly invention of some frivolous mind. The thing trembled at a touch, the shelf scraped my shins, the microscope danced, the lamp wabbled, and the deluded victim expressed his opinion. Æsthetics are well enough, but they should be looked for in the object under the lens rather than in the table. I now use a strong, substantial, four legged pine table that cost less than

three dollars, and I would not change it for a Louis XIV. or a Chippendale. All that is needed is that it shall be solid and firm, with an abundance of top space, and a drawer or two to hold the many "traps" and "dodges" that soon accumulate.

Seated before the stand, incline it at a convenient angle, the stage, the mirror, that is, the front of the microscope, of course being turned from you. When inclining the instrument, do so if possible by means of the arm, at any rate do nothing to bring a strain on the coarse or fine adjustment. All the least costly stands will remain in an inclined position, held there by the friction within the joint at the top of the pillar; in first class instruments the trunnions carry tightening or binding screws, so that the wear that sooner or later becomes noticeable in the former can be taken up in the latter.

With the eye-piece in place, and the body inclined, attach the objective. To do this, rack up the body until there is no danger that the front of the lens will come in contact with the stage. Unscrew the top of the brass box containing the objective and tip the latter out into the palm of the left hand, supporting it with the fingers. Take it up with the right hand, and turning the screw end upward, screw it to the lower end of the body tube. It is unnecessary to caution the reader in regard to crossing the threads of the screws. If that be done and the objective wedged into the nose-piece, the owner of that stand may have a sad experience. Mr Wm. Wales relates an instance of this kind where the objective could not be removed by hand, so the wise owner used a heavy pair of gas-fitter's pliers, and succeeded in damaging the instrument to the amount of forty-five dollars, pulling out the entire fine adjustment which in this case was on the lower end of the body. It is often useful to rotate the objective backward for a short distance, until the threads are felt to slip into place, when the lens may then be screwed home by gentle forward turns. If it does not move easily and smoothly, something is wrong, and no force should be applied, but the objective must be removed and the difficulty discovered and corrected.

If the microscope is to be used by day-light a position near a north window is the best, as the light from the northern sky is the most uniform. A white cloud illuminated by the sun is the most desirable light by day, but it can seldom be obtained. Most microscopists have some favorite position before the win-

dow, many preferring the stand so arranged that the mirror shall face the window and the sky; others place it so that the window shall be at the side of the instrument. This is entirely a personal preference, nothing, so far as I know, being gained or lost in either position. If, however, day-light is used with a substage condenser, the plane mirror should be turned toward the sky. If no substage condenser is employed, then the concave surface should be directed upward.

The use of lamp light has already been referred to, and the employment of some special form of microscopical lamp recommended. Its position in relation to the mirror may, if desired, be ascertained by the formulæ given in a preceding chapter, but I think most microscopists, for ordinary work, do not enter into the niceties of such an arrangement, reserving these refinements for some very special and delicate investigations. The reader will find, however,that any attention paid to these points, even for everyday observations, will result in good. Usually the lamp is placed somewhat in advance of the microscope and always on the left hand side. This gives plenty of room on the table, so that the lamp is in no danger of being overturned. If the observer should be left-handed the converse arrangement would of course be necessary.

PUBLISHERS' NOTICE.—For the past year, and in several instances for a longer time, we have been carrying so many delinquent subscribers, who, when a bill is presented, refuse to pay it, although they have for a year received, retained and presumably read the magazine, that in self defence we are forced to make a change. Before the issuing of the April number of THE MICROSCOPE the names of all subscribers who have not paid for 1890, and in advance for 1891, will be stricken from our lists. With the issuing of the December number of each and every year, the names of all subscribers that do not pay in advance

for the following year, will be stricken from our lists. This rule, which will recognize no exceptions, will be a protection to publisher and to subscriber. While the publisher and the Editor are willing to give the microscopists of the country the benefit of their time, and of whatever skill and learning they may possess, the compositors, the paper-maker, the book-binder and the United States postal authorities are not so philanthropical. But the publisher and the Editor, after giving their time, labor and knowledge, are not willing to give of their limited means for the privilege of teaching and interesting microscopists who, having received the magazine for a year or more, refuse to pay its small subscription price.

Again calling attention to the arrangement now and hereafter in force, and to the fact that a receipt will always be sent if a stamp or a postal card accompanies the remittance,

We remain,

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VERY much has been said by many writers as to the selection of objectives by the amateur or the novice. And there is room for much repetition, as the beginner will find it rather easier to go astray and to make mistakes in this department of life than in almost any other. He will find that after he has irrevocably committed himself to a purchase, the object of his wishes may not be all that his fancy painted it, and he will be ready to part with it on any terms, and to supply its place at an expense that, if it had at first been judiciously invested, would have returned him a satisfactory interest in the good work that it would have enabled him to do, and in the pleasure that the work would have given him. There is no economy in buying a cheap objective. It is too sure to become a nuisance and a hindrance; it is too sure to be more expensive in the end than a lens that seemed to be costly at the beginning. A good objective will improve upon acquaintance, because the investigator will himself improve in skill and in that enviable ability to see minute objects that to the beginner is a wonder as possessed by the expert microscopist.

The use of good objectives will improve the eye sight; it will make the retina more sensitive, and the brain cells more readily impressed. And there is a beauty and a brilliancy about the

image formed by a good objective that is entirely lacking in the performance of a poor one, or of one that is not first class. It is advisable therefore always to select the best that the purchaser can afford to buy; and if he cannot take the two or three that he will need, and have them all good, it is much better to take two or even one that shall be at the top of the list in regard to performance, rather than to burden himself with several of a second rate, and be compelled to waste his time and money, the one trying to see what they can not show him, the other in sacrificing them in order to get better that he must have or fall behind the workers that are no more than his equals in study with the instrument. A good brain must have good objectives to work with, or the microscopist with the good brain would do well to put an immediate end to his attempts to go forward, as it is the duty of every man to do. It is a Bible command, this of going forward. Progress is ever the watch word in spiritual things, as it is in the affairs of the world. It is emphatically so in the microscopical world. The microscopist that attempts to stand still will soon be left behind, lost in the mists and the swamps from which he will never escape. He must go forward or disappear. To do it he should have good objectives, or he would do well to stop at once and go to digging ditches for a recreation, or to white-washing for a pastime.

The reader cannot too soon free his mind of the belief that he can get something for nothing. That is contrary to Nature, for even Nature which seems to be so open handed and generous, demands her price, and sooner or later gets it although it may leave the victim bankrupt. Optical tools are works of skill and the result of skilled labor, and we must pay their price, although it may at times seem excessive, and in many cases is excessive. But a good thing is always worth its price. That too is a law of Nature. A good objective will take considerable hard earned money, but it will never deteriorate, unless the reader shall select an apochromatic; of these he may be suspicious, as they seem destined sooner or later to undergo an obscure chemical change that makes them semi-opaque. Other kinds can be trusted to remain as good after fifty years of use as after one. Let me repeat then. Get the best that you can afford at the beginning. If two cannot be taken, then take one and wait for the other.

Much, too, has been said about an ideal series of objectives.

I have no ideal series to suggest, but I have a series that I am sure the reader, especially if he be about to buy a microscope, will find of great service, and one that will remain good to the end, and will enable him to do considerable original investigation, if he so desire. In mentioning the objectives, I have no other purpose than the one that I have attempted to make prominent. The dealers whose excellent work is to be mentioned are welcome to the advertisement. It should be a greater one if I could make it so. And the reader may rest assured that any coincidence that he may notice between the names of the opticians in this list and in the advertising pages of the magazine, is a coincidence only. Every one of these objectives was bought, and had been used for several years before I had the least thought that I should ever be the Editor of THE MICROSCOPE. If the accomplished gentlemen to be named shall sell more of their objectives by reason of this notice, no one will be better pleased than I. Their work is fine; it merits every commendation, and I am happy that I can give it. I can therefore recommend the following as a list of good objectives that I am familiar with, and that the reader will find satisfactory in every particular, and with which he may do original work. If he does not care to perform that nerve-wearing labor, then these lenses will give him glimpses into the secrets of Nature that no others of a lower grade could ever show him.

For a two inch, which is very useful at times, take Queən and Co's; for a lower power, that is hardly needed except as a luxury, Zeiss's variable A* is superb; this may be varied from a three to a five inch. For the one inch by all means select Spencer's, of 33° aperture. Beyond this nothing will be needed, except as a luxury that may be dispensed with, until the $\frac{1}{5}$ is reached. This should be Gundlach's, Class D, 135° aperture; and the highest power needed by any one, unless he is going into delicate investigations, is the $\frac{1}{8}$, that should be the best made and homogeneous immersion. For this lens take Messrs Bausch and Lomb's. It is a superb thing and worth every dollar that it costs. Should the reader desire to go higher, as he probably will not, then he may confidently select Spencer's homogenous immersion $\frac{1}{16}$. This is magnificent. It is the equal of any thing made by any optician any where in the world, not excepting the apochromatics of Zeiss. But with the $\frac{1}{8}$ the microscopist has all that he

will need. With it he may do all that he may wish. It will give him as high a power as he need desire, since it will show him all that a higher could show, and do it better. With these four splendid objectives the reader will be the microscopical peer of microscopical workers, of course excepting the bacteriologists that demand powers even higher than the [1]. He will never need any others, unless he is able to possess luxuries, with which this little note has nothing to do.

Let me once more repeat. If you cannot take these four at one time, take one at a time, and begin with the one-inch. That will do commenable service, and will last the microscopist his life. He will never feel the least inclination to change it. And his feelings toward the others will be exactly the same. With these four he should be happy.

DR EDWARD GRAY, Benicia, Cal., has recently taken the agency for Reichart's admirable objectives. These lenses are praiseworthy in every respect, as I know, having just had the satisfaction of examining the homogenous $\frac{1}{12}$ referred to in this Department for June last. A note from England says that Reichart has recently made a pocket-lens that seems to be superior to anything of the kind that British microscopists have heretofore seen.

I am also glad to announce that Miss M. A. Booth, Longmeadow, Mass., has taken the agency for Thum's arranged objects. These are magnificent things, and the low price is in no way comparable with their excellence.

NEWS · FROM · THE · WORKERS ·

THE BEADS, OR PEARLS, OF PLEUROSIGMA ANGULATUM[1].

I PUBLISHED in the month of February last (1890), in this journal (*Journal de micrographie*), an article on the pearls of

1 J. Pelletan, the Journal de Micrographie.

Pleurosigma angulatum, in which I contended, against many distinguished diatomists, especially against my learned confrere and and friend Dr A. Van Heurck, that the so-called pearls are not hexagonal cells, deep like those of a honey-comb, but pearls as indicated indeed by their name, that is, projecting granules. I saw in those little arching grains elements of a sphere, that should be hexagonal at the base though mutual pressure, but round in their relief, that is, giving circular optical sections. I reasoned not only on account of my personal observations, but especially through exceedingly beautiful photographs, enlargements of plates obtained, some by Dr. H. Van Heurck with the Zeiss apochromatic, N. A. 1.63, others by M. Ch. Basset with Bézu and Hausser's water immersion $\frac{1}{12}$ inch objective.

Among diatomists there are, on this subject, three camps; the first, now the most numerous, I believe, contending, with Dr H. Van Heurck, for deep hexagonal depressions; the second, like M. Ch. Basset and myself, arguing for projecting generally rounded pearls; the last belonging, as my friend G. Percheron says, to the sect of the celebrated Chinese philosopher Ki San Fou.

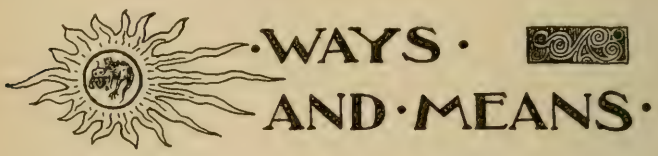
Well, in the latest number of *Le Diatomiste*, issued by M. J. Tempere, M. Leon Duchesne publishes an elaborate article on the pearls of *P. angulatum*, basing his arguments upon the different results that he has obtained by micro-photography, while working with the same objectives, under the same conditions and over the same valve, but by slightly changing the point of view. He thus proves that the pearls are in relief and round. When the focal plane is tangent, or nearly so to the pearls in a certain part of the valve, each bead is represented by a black point (the summit that is in focus), surrounded by a white ring (the rest of the pearl that is out of focus); as the focal plane is lowered, each pearl gives a larger and larger circular black image surrounded by a smaller and smaller white ring. It is a series of comparative optical sections.

As we continue to lower the focal plane, the relief of the pearl ends by being no longer in focus, and we obtain an image of the bead, or even a deeper image taken through the thickness of the valve at the level at which the pearls originate. And this is hexagonal, doubtless through reciprocal pressure.

It is precisely this that I contended for and that he has de-

monstrated. Now it is necessary to recollect, and I have very often said it, that images of very finely striated structures can by diffraction be modified to an extreme degree. Experiments formerly made with Abbe's test have shown this most emphatically. It is well, I think, not to allow one's self to become too deeply puzzled by the ultimate form of these infinitely little details, for in such cases the microscope can no longer be a faithful instrument since it shows us photographs of illusions.

And each microscopist can see different things, according to to the objective, the cover, the medium, the illumination that he uses, and all those images about which we argue at random, may each represent a thing that does not exist.



DIFFERENTIAL STAINING OF HUMAN BLOOD CORPUSCLES.

F. A. ROGERS, M. D.

THERE is scarcely anything which is easier to prepare for microscopical examination, or which affords a prettier object to look at when properly prepared, than a slide of differentiated blood corpuscles.

The article published by Dr Heitzmann in THE MICROSCOPE for May, 1890, is full of interest, and recently I have verified some of the statements there presented in relation to the colorless blood corpuscles.

My object now, however, is not to discuss the differences of the colorless corpuscles diagnostic of the general constitution so well presented in that paper, but to show an easy way of coloring a specimen of blood so that the red and the white corpuscles shall be properly differentiated, and when mounted shall afford a slide which will delight anyone to study.

The easiest and least objectionable way I have found by which to obtain a specimen of blood is to proceed as follows. Having cleaned the left fore-finger, take two or three turns tightly around it just above the second joint with a pocket-handkerchief; then

strongly flex the first and second joints which will cause the finger below the handkerchief to be filled with blood.

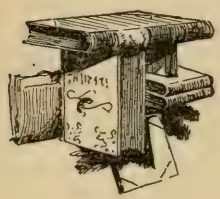
Previous to this procedure two cover-glasses should be cleaned and be placed in a handy position, and also a cambric needle whose point has been passed momentarily through the flame of an alcohol lamp should be near by. By lightly pricking the finger upon the dorsal surface between the first and second joints a sufficient quantity of blood can be obtained and with scarcely any discomfort.

Now breathe upon one cover-glass and touch it to the drop of fresh blood, and immediately breathe upon the other cover-glass and lightly place it upon the first. Just enough moisture should adhere to the cover-glass so that the blood will diffuse itself over the entire surface of both.

The glasses are now to be carefully separated by a sliding and circular motion, and if properly done there will be two cover-glasses with a single layer of corpuscles over each. Allow them a few moments to dry, then pass two or three times quickly through an alcohol flame and lay them with the coated side uppermost upon a sheet of blotting-paper. With a drop-tube place two or three drops of eosin solution upon each glass, spreading it carefully over the whole surface; let it it remain five minutes, then wash the glass by waving it in water. The glass is again placed upon the blotting-paper with the coated surface uppermost, and with a hand-bulb, such as dentists use to dry the cavity of the tooth, blow all the water from the surface so that it may be immediately absorbed by the blotting-paper. If the water which adheres to the surface of the cover-glass is not removed at once, it will by dissolving and diffusing more of the coloring matter, render the whole specimen worthless. Proceed in the same way with anilin blue; let it remain five minutes; wash and dry in the same manner, and finally mount in balsam.

If properly prepared, the specimen will show under a power of from 600 to 1,000 diameters the red corpuscles colored a beautiful pink, and the white a pale blue or light purple with several dark blue nuclei in each. It affords an easy way to compare the number of each kind of corpuscles in a given specimen, because they are so sharply and so beautifully differentiated.

CARBOLIC ACID FOR DEHYDRATING.—In insect work I have found carbolic acid a very great help. In addition to the turpentine solution mentioned in the October number of THE MICROSCOPE, I have a solution made by dissolving the pure detached crystals of carbolic acid in just enough strong alcohol (absolute preferred) to liquefy the acid, with aid of a gentle heat. This solution has great affinity for water and will readily extract it from any object, hence its utility in clearing insect specimens. The skin of the ordinary cricket containining the spiracles, taken from a fresh specimen, washed in water and then placed in this solution, will be entirely dehydrated in less than five minutes; now by placing it in the turpentine oil for a few minutes, to free it from the alcohol, it will be ready to mount in balsam. It is possible in this way to mount a thin object in less than fifteen minutes from the time you dissect it. This method is especially applicable to such objects as the skin and wings of insects, gizzard of cricket, etc. In addition to the saving of time, as the object is handled but once it will be much more likely to remain in a whole condition, especially in the case of a delicate structure, than by the old potash process. One word of caution in using this strong solution; it is a poison, and is besides very caustic and must be kept from the hands and clothes.—E. W. SHARP. PH. G.

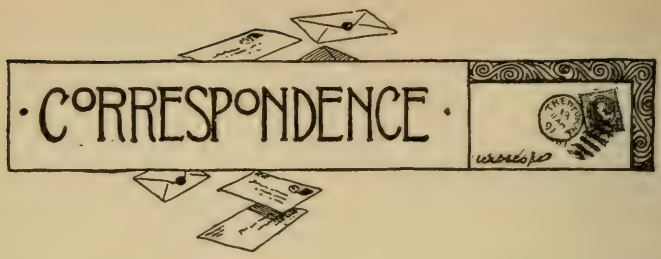


NEW PUBLICATIONS

THE DIATOMACEÆ OF NORTH AMERICA.—Rev Francis Wolle. Illustrated with 2,300 figures. 8vo. Price $6.00. Bethlehem, Pa.: The author.—Mr Wolle's "Desmids," "Fresh water Algæ" and this volume together form a complete treatise on these three great groups of aquatic plants as found in this country. The monographs form a monument to the author's learning, skill and indomitable energy. To have looked forward to the preparation of this volume on the Diatomaceæ must in itself have been a formidable prospect. The literature of the subject is perhaps

more widely scattered than is that of most other microscopical subjects, and the work of collating it is enormously increased by the obscurity of many of the journals in which the original descriptions were published, to say nothing of their rarity, their cost and the difficulty of obtaining them; yet Mr Wolle has overcome all these obstacles, and has here given drawings of every form known to exist in North America. The labor has been great, but the result is a monograph that no microscopical student can afford to ignore. Even for those that "potter about on the edges of things" it will be an incentive and a valuable aid to work. To be able to identify those Diatoms with which every drop of ditch water is loaded that comes to the microscope stage, will be a comfort and a delight; and the possibility of finding this help, with an illustration and references to the literature of the subject included within a single volume, must act as a stimulus to further investigation. Not only are American Diatomists under obligations to the author, but the amateurs that have hitherto seen the plants and passed them by because of the difficulty of identifying and of studying them, will owe him a debt of gratitude. The monograph should arouse wide spread interest in the beautiful objects, and no reader of THE MICROSCOPE that feels the slighest inclination to study them or even to ascertain only their names, should fail to own the book. The edition is limited to four hundred copies. The auther should have no difficuly in disposing of them, especially at the price.

By the use of analytical keys Mr Wolle leads the microscopist through the tribes and families to the genera, after which, to learn the species, it is expected that he will compare his specimen with the illustrations, and as every known North American form is figured, there need be little trouble in this part of the study. For those that are not experts in the identification of the Diatomaceæ, Mr Wolle has smoothed the path in a way that will be exceedingly encouraging.



EDITOR THE MICROSCOPE:—

The January issue of your welcome journal has just been received. In reading your article on the use of oil of cajeput I find that you have evidently fallen into error, or misquote yourself in regard to the use of absolute alcohol.

I have never met with any difficulty in transferring specimens soaked in oil of cloves direct into balsam as a mounting medium. I have always used absolute alcohol to dehydrate specimens, before passing them into oil of cloves. My order of procedure has been as follows: From water to ordinary alcohol, from this to absolute alcohol, then in oil of cloves and from the oil into balsam. I hope to find time for writing to you in regard to the use of oil of cajeput, as I have had some experience in that direction. Yours truly.

H. M. WHELPLEY.

[In the article on cajeput oil in the January number, the statement is made that "an object cleared or soaked in the oil of cloves can not well be transferred from it to balsam without the intervention of absolute alcohol." This is a mistake. It should read: An object soaked in ordinary alcohol cannot be well transferred to the oil of cloves without the invention of absolute alcohol.—ED.]

EDITOR THE MICROSCOPE:—

"Amateur" has been writing freely on the microscope as an instrument, and has shown himself to be more than a mere amateur on that subject. But now that he touches upon the practical application of the instrument he shows himself to be a true amateur, and I fear a very narrow one. I refer to the paragraph in the January, 1891, number, page 16, where he begins by passing his opinion on the assertion made by those

studying Histology and Embryology, that the vertical position of the microscope is essential to the proper study of these subjects.

I suppose every man has a right to believe a thing or not, and also to state it; but when one says that he does not believe the vertical position of a microscope essential to the proper study of Histology and Embryology, and I may add to the whole field of Biology in its broadest sense, then he simply shows without the shadow of a doubt, that he is as far from being a worker with the microscope in Biology, as the scores of other pleasure seekers who use the instrument to see pretty things. No person can work (and when I say work I do not mean merely to prepare and mount specimens to look at), with any degree of earnestness, to say nothing of thoroughness, in a single one of the fields of Biology and not be compelled to use the microscope in a vertical position. Nor can he, no matter how much one may wish to, mount any where near all the objects to be examined and studied. Looking at mounted histological or embryological objects, or whole animals or plants is all very nice, but how often can we mount the object so as to incline the stand? We are only too glad to incline the stand when we can do so, simply because it is easier to look into and less tiresome, but to use it that way is impossible in fully one half the cases. The instant the stand is inclined gravity begins to make itself manifest in many ways; and if we are looking at an animal that normally has its dorsal aspect uppermost, when we tip the stand the animal tends to preserve its proper position, and if it does and we tilt the stand to horizontal we will be looking at its lateral aspect. There are cases where the stand can be inclined and not interfere to any extent with the object, and in each case we are only too glad to do so, as for instance in the study of the Rhizopoda and Infusoria. Here there is rarely any need of more water under the cover-glass than will remain in place when in any position, and if we wish more water we can place the objects in a life-box or compressorium. However, a life-box eats up a great amount of time if one be constantly changing objects and has to clean the glass each time. With the best of care, however, certain shelled Rhizopoda will roll and become entangled or lost in dirt and other matter under the cover-glass, if the stand be inclined to an extent to be of any advantage.

But Protozoa are not all the animals to be studied, and when we attempt to study the numerous Cœlenterata, we are compelled to use the microscope in a vertical position. Life-slides in studying Ctenophora and Hydrozoa, or Acalephæ in general, are as unable to admit of being inclined as a watch-glass or some kind of glass trough which is, next to the microscope itself, an indispensable article. The same thing holds good with reference to the embryo, of nearly all the invertebrates. It is but a short time ago that I was studying the fresh-water polyzoa *Cristatella*, and if any one can study such animals with the microscope inclined he is welcome to do it; I can not. Then again the numerous physiological experiments involving the use of the microscope, and the total or partial replacing of liquids by others and by reagents while watching their effects on the organism or tissue, and numerous other cases, involve the use of the microscope in a vertical position.

As regards the neatness of a histological or biological laboratory, allow me to state that there is no more occasion for its being a "sloppy and an unattractive place" than for a parlor to be such, and the fact that we are compelled to use our microscopes in a vertical position has nothing to do with it. There is no more need of using liquid to excess so as to cause it to run over the slide, microscope or table, than there is of using a quart of oil at one time on a sewing machine. My private laboratory is as neat and clean as any drawing-room, and yet all my work is done on two large felt covered, flat top desks which are as clean as if not in use. There is no excuse for uncleanness in any work with the microscope.

Every microscope should be made so that it can be used in a vertical position or inclined at any angle, and no worker should think of purchasing a stand that is rigid so not to be inclined, any more than he would of purchasing one that is inclined with no joint for placing it in a vertical position. However, if compelled to choose between the two, the one that is vertical should be the choice of all workers, but from all I can see "Amateur" might just as well have a stand made permanently inclined.

WASHINGTON, D. C. J. M. STEDMAN.

EDITOR THE MICROSCOPE:—

In relation to the Star cleaning powder I may mention that

it is one of the intra-glacial deposits of Diatomaceæ, which are on the first glacial drift of New Hampshire, and possibly of Maine, Massachusetts, Connecticut, New York, Rhode Island, and New Jersey. How far south they extend I do not know, but most likely to the termination of the moraine left when the ice retreated. They are all one. That is to say, they are one stratum laid down at the same time on the moraine or the drift. There may be one more moraine but that is more recent. They are called infusorial earths, subpeat or lacustrine sedimentary deposits. They contain truly fossil Diatoms, the oldest fresh-water Diatoms known. Where there has been any volcanic action and erupted trap is poured out, it has changed the diatomaceous material to a hard stony mass, and the organic matter is burned away leaving the material of a white or nearly white color. One that I had from Greenwich, Conn., was white, hard and stony, and possibly was so changed by volcanic action. The electro-silicon is one of these. It is from six-mile canon, near Virginia City, Nevada, and is the remains of a great lake or inland sea, two of which are known to exist. They are thus described in Jos. Le Conte's Geology, page 554: "The valleys between the parallel ranges were then filled with water, forming two great lakes nearly as large as Lake Superior, one filling the Utah, the other the Nevada Basin; the one named by Gilbert, Lake Bonneville, the other by King, Lake Labontain, in honor of the early explorers of this region." So that electro-silicon is an intra-glacial deposit of fresh water Diatomaceæ. I determined this last summer when examining the Waverly, New Jersey, deposit. It is from Lake Bonneville, but I had some from Lake Labontain also. I hope this is made clear to all; geologists were only wanting this evidence of the age the Diatomaceæ.

NEWARK, N. J. ARTHUR M. EDWARDS, M. D.

EDITOR THE MICROSCOPE:—

Your contributor "Amateur" apparently has his opinions regarding microscopes; with several of them I may be allowed to differ. Will you allow me to suggest to intending purchasers that it is well to hear both sides, and that before they buy they get the opinions of some who are doing the real work of to-day? I would advise them to consult the professors of botany and zo-

ology in Harvard, Massachusetts Institute of Technology, Clarke University, Princeton and Johns Hopkins, and they may learn something in favor of the despised German stands, and they may learn of some of the many faults to be found in those American makes with which "Amateur" is so deeply in love. Certainly the test of a microscope is the work which can be done with it, and I have never seen any work done with an American stand and objectives which can compare with the work done in America with the instruments of Zeiss, Leitz and Hartnack.

Yours truly,

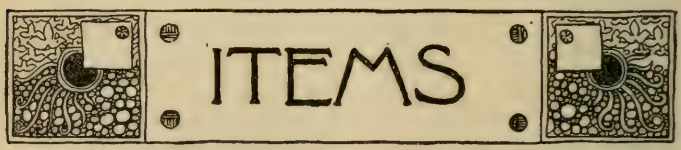
UNIVERSITY OF NEBRASKA, LINCOLN, NEB. J. S. KINGSLEY.

EDITOR THE MICROSCOPE:—

There are two or three of the papers by "An Amateur" that I have not seen, but those that I have read stamp the series as the best practical information I have ever seen by any one and the same writer. While there are some points upon which my experience to a certain extent would differ, still as a consistent whole the series is highly deserving of being published in book form to be placed in the hands of students, be they beginners or earnest workers.

Yours truly,

NEW ORLEANS, LA. GEO. C. TAYLOR.



Mohammed's favorite flower was the Narcissus, probably the yellow daffodil, that grows abundantly in western Asia, and he gave his followers this counsel: "Whoever has two loaves of bread, let him trade one for a blossom of Narcissus; for bread is nourishment for the body, but the Narcissus is food for the soul."

When, in protoplasm, the matter out of which the plant cell is built up was discovered, it was believed we were nearing the problem of the origin of life. But no one has ever made it any clearer than before how life came to be given to even this pristine, organic material. Dr Julius Wiesner now contends that even protoplasm is made up of *plasomes*, and that the whole mass of material is formed from the original plasome by division, just as one cell is by division formed from another cell. Whence the life in this original, minute and almost inconceivable plasome is derived is as much a mystery as ever—*The Independent.*

THE MICROSCOPE

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ORIGINAL COMMUNICATIONS

THE MICROSCOPIC STRUCTURE OF CERTAIN FEATHERS.

DR P. L. HATCH,

PRESIDENT MINNESOTA ACADEMY OF NATURAL SCIENCE.

COMPARATIVELY few objects with which we are surrounded come distinctly within the range of vision because of their size being too great, or too small, and of those that are visible only a small portion arrest attention sufficiently to secure careful consideration although some striking feature of outline, proportion, or color, or some remarkably evident adaptation to a given purpose may do so occasionally, when we are at once impressed with the perfection of detail in the structure. Some persons are thus led to habitual observation of every perceptible characteristic in the constitution and relations of parts of special objects, unconsciously initiating themselves into a world of infinitudes in either direction, and especially so when beguiled into the employment of modern optical facilities.

Gross objects come into conscious perception without sensible efforts, or demanding trained habits of vision, commanding attention by their size; imposing themselves upon us *nolvens volens* by their magnitudes; filling us with the profoundest inter-

est without leading us irresistably to their minute analyses. A passing bird, a falling snowflake, or the immaculate purity of a flower may arrest the attention of the casual observer, but will not awken the enthusiasm characteristic of one who has tasted the pleasures of microscopical research in the optical investigation of Nature's wonderful revelations. One whose authority has universal acceptance in all Christian lands, has said that Solomon in all his glory was not arrayed like the lily, yet one of its petals under the proper lens when beheld by well-trained eyes, will not less surprise by the revelations of its structure.

The graceful swan immortalized in mythology and in song, reveals more that is wonderful in a feather thus viewed, than in itself as a whole as ordinarily observed. This is true of most birds, strange as may seem the apparent solecism, yet in consideration of the circumstances under which they are seen, nothing is assured, and what may be said of the wonder revealed in the microscopic elements of a feather may be said with no less emphasis of their adaptations to their uses in the economy of the entire plumage. To make this evident a brief description of a typical feather will first be given.

It consists of a stem, the lower position of which is horny, naked, and cylindrical, called the calamus or barrel; the upper and longer portion which tapers symmetrically to a point, is the rhachis, or shaft, and is squarish, horny externally, and filled with light, compact pith-cells. At the junction of these two divisions inferiorly is a depression called the superior umbilicus from a little below which arises the hyporchachis, or after-shaft. The inferior umbilicus consists of the opening in the dermal end of the calamus through which the nourishment of the feather is maintained. Commencing at the superior umbilicus there extends on each side of the shaft a vane or vexilla, composed of a series of flat, lanceolate, appressed barbs springing from the superior, or external angle of the shaft. Between these vanes inferiorly, begining at the umbilicus, there is an obtuse-angled groove extending to the apex of the shaft. The barbs are relatively broad at their base, narrowing to an acute point at the extremity and bearing barbules along the external borders of the shaft. The barbules are to the barbs what the barbs are to the primary shaft, and in turn bear on their inferior border, after an expansion like that of the barbs, a series of less compacted

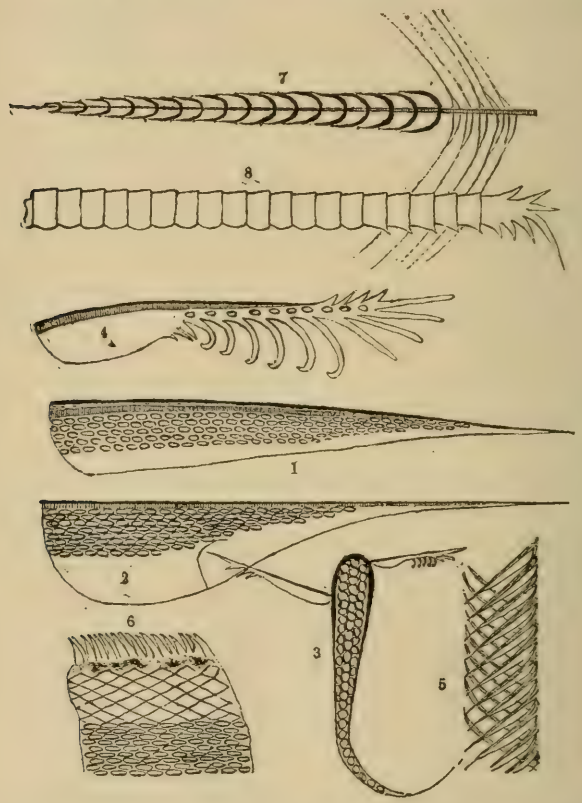
barbicels, of two forms called hamuli or hooklets, and cilia. By these barbules of the anterior series overlying those of the posterior series of the next preceding barb, and attaching themselves by the hooklets, a web is formed of the vane of the feather. The barbicels of the posterior series of barbs seldom bear hooklets, but cilia only.

This description of a feather is a sort of base-line from which to make surveys into unexplored fields of investigation. There are three groups of feathers, the one given representing the pennaceæ or feathery, the second the plumulaceæ or down, embracing those having the stem short and weak, with soft barbs and shaft, long slender thread-like barbules with knotty dilations instead of barbicels without hamuli; the third the filoplumaceæ or hairy, containing those with a thin, stiff calamus with no pith in the rhachis, fine, cylindrical, stiff barbs and barbules, with no barbicels, knots or hamuli. All feathers so far as known are constructed upon one of these three plans in general, but in their various modification in different species of birds, as well as in the different parts of the same bird, the group-characteristics are frequently found present in one feather, and some of the more striking variations arise by the partial, or total absence, or the excessive development of one or more of the elements of a typical feather.

Having outlined a typical feather as it appears to the unaided eye, the way is prepared to examine some of its modifications, found in its minuter structures which are only to be seen by employing the microscope. We will pluck off a single barb of the anterior vane of a primary in the wing of a domestic pigeon. Fig. 1 is a diagram of such a barb in lateral view. The shaft of the barb may be seen represented by the dark line of the upper border, immediately below which are the remaining stubs of the excised barbules and under which are the pith-cells of the expanded, appressed shaft.

These cells disappear some distance above the transparent inferior border that consists of the united, horny envelope of the pith, terminating in this barb with an exceedingly minute frill of fimbreæ. Fig. 2 represents, also a side view, a barb from the primary of another species under the same magnification. In this the shaft is inconspicuous, the anterior row of barbules being inserted at its extreme upper angle, and the thin expansion

of its membranaceous portion [is] much greater, giving it a less linear pattern, while the inferior margin has no frill. Fig. 3 gives a transverse section of the barb shown in figure 1, the shaft of which is distinctly arched above the insertions of the barbules, the point of insertion of the posterior series appearing considerably below, on the opposite side. The horny exterior of the barb, thick, and firm superiorly, is seen to diminish in thickness downwardly in the same proportion as does the inclosed pith,



which shows three cells in breadth diminishing to two, then to one, after which nothing but the enveloping tissue, that from transparent angulated cells, passes into semi-opaque amorphous matter at the base of the fimbriated bodies[1]. This section brings into lateral view the barbicels of both the anterior and

1 As seen in Fig. 6, which represents the vellum of the barb and its frill.

posterior series. the former bearing hamuli and cilia, while the posterior has cilia alone. The curvature of the downward expansion of the barb is uniformly toward the row on which the hamuli are found.

The difference in the degrees of elevation of the two series of barbules on the sides of the barbs as shown by figure 3, is as marked as its purpose will be evident when the relations of these series to each other are considered. Fig. 4 is a more highly magnified delineation of an anterior barbule, showing distinctly the two forms of barbicels, hamuli and cilia, while Fig. 5 shows the adaption of the two series to each other.

EXPLANATION OF FIGURES.

Fig. 1. The anterior side of a barb from the primary of a domestic pigeon, with its barbules cut off close to the rachisett which rises distinctly above them; beneath them the pith-cells, below which the transparent, horny exterior of the barb is seen.

Fig. 2. A barb from another species, with the anterior barbules removed showing no elevation of the superior rachisett and a broader vellum below the pith-cells.

Fig. 3. A transverse section of a barb with its barbules in position, the anterior being the more elevated and bearing both hamuli and cilia, while the posterior and lower bears cilia only.

Fig. 4. A barbule with its armature of barbicels of both kinds, greatly magnified.

Fig. 5. Two series of barbules in their relations to each other *in situ*, the anterior overlying the posterior, thus forming the meshes of a web, the barbicels being concealed.

Fig. 6. An exaggerated delineation of the fimbriated border of the vellum of a primary barb; of exceptional occurrance apparently.

Fig. 7. Outline of a barb from a feather found in the crest of a Kingfisher showing barbules of a remarkable type.

Fig. 8. A barbule from a barb of a long feather in the Peacock's tail. Except the crude ciliation at the extremity it bears no resemblance to any element of true feathers, being comparatively nonelastic, and apparently chitious in composition, yet rivaling the elytra of the famous Brazilian beetles in the iridescence of its changeable reflections.

A MICROSCOPICAL STUDY OF SOME INGREDIENTS OF THE SPUTUM.

WILLIAM B. CANFIELD, A. M., M. D.,
LECTURER ON HISTOLOGY, AND CHIEF OF CHEST CLINIC, UNIVERSITY OF MARYLAND.

THE microscopical examination of the sputum or products of expectoration is not always agreeable, but it yields often such

satisfactory results, that the practising physician is many times repaid for the trouble. Such an examination is rarely made except when looking for abnormal ingredients to assist in confirming or correcting a diagnosis. The presence of tubercle bacilli or elastic tissue in the sputum is often the first sign of dangerous pulmonary trouble, and this early sign, detected often long before physical signs point to the disease, enable us to act promptly, and at times to avert or cure a disease so frequently considered incurable.

In addition to these two abnormal ingredients of the sputum there are found, as normal ingredients, those round or oval cells, perhaps, in some cases, cast off alveolar epithelium or else leucocytes. These cells rarely fail in normal expectoration. They are a little larger than the lymph cells, and are brought up by the ciliated epithelium, and cast out in the expectoration. When examined under proper conditions, they show amœboid movements. In health, they seem to have no particular function, but in certain diseases, they are of great use.

Their function has been brought to my attention recently in studying several cases of what I thought was pulmonary consumption. The physical signs not giving sufficient information, a history of the patients' occupation and former life and also an examination of their sputum threw light on the subject. Case I. was a worker in a slate quarry. Case II. a stoker who had worked for from thirty to forty years in the cellar of a factory, putting on coal, and living in an atmosphere of coal and ash-dust. Case III. was a man who had worked for more than twenty years in an iron foundry, where his principal occupation had been at the lathe, turning articles of iron and leaning over his work breathing in the iron dust. Case IV. was a man who worked for several years in what he called a "clay factory," and giving that up because he could not stand the dusty atmosphere which he said made him cough and short of breath, he sought for some time other work and finally, in despair, took a position in the B. and O. R. R., cleaning out furnaces, where he is again exposed to a dusty atmosphere but of a different character. The expectoration of each case was slightly colored according to the character of dust inhaled, and Case II. still continues at times to expectorate dark and even black sputum, although he gave up his position one year ago. An examination of specimens of

these cases for tubercle bacilli, showed them to be absent in all cases except the first, but in each specimen those round cells were present in increased number and containing in the case of patient II., bits of coal and coal pigment. In some specimens, the crystalline character of the pieces of coal could be recognized within the cell wall, but more usually the cells were dotted with black points. Of course this has been observed before in patients under similar circumstances, and also in the morning sputum of smokers, but the whole subject seems interesting when the function of these cells is considered.

To take a hasty view of our manner of breathing, it can be easily seen that man being upright and far from the ground is not so apt to inhale certain kinds of dust as grazing animals, hence his nasal passages are more simply constructed. They are moist, and this moisture undoubtely stops the entrance of dust; the secretion is slightly acid, which may act fatally on invading bacteria. Then dust and foreign particles have to contend against a sensitive larynx which may cough them out, and a very active ciliated membrane which is constantly carrying on its waving motion from the small bronchi up towards the larynx, and must drive out dust which gets thus far. Now the role of these cells, which are evidently carrier cells, scavenger cells, wandering cells or phagocytes, is to seize such particles which penetrate to the alveoli of the lungs, carry them off or render them harmless. It is easy to see that the ciliated epithelium can much more easily carry off a round or oval cell which is easily moved, than it can take away very small bits of dust, often angular. In the cases mentioned, the phagocytes are disposing of these foreign substances either by helping them out of the lungs through the trachea in the expectoration, or in cases where the angular pieces of coal or slate dust make their way through or between the alveoli into the lung tissue, the phagocytes carry them by the lymph channels to the nearest lymphatic gland, where they are at least harmless. In Case II., it is interesting to note the activity of the phagocytes still attempting to carry off what dust they can find, although it is a year since the man gave up his occupation. In such cases as those cited, a post-mortem examination of the bronchial glands shows them to be absolutely black, grey, etc., according to the character of the dust inhaled. Indeed all city dwellers have to a certain extent these dark

bronchial glands, and their lungs are pigmented, while the country dwellers and all infants have light or even pinkish colored lungs.

To return to these cases, it is evident that they all have a non-bacillary phthisis; the lung-wasting being caused by the deposit of dust which is quite sufficient to cause breaking down. In Case I., in which bacilli were found, my theory is, that the case was not originally bacillary, but that the constant irritation of the dust wounded the delicate alveolar walls of the lungs, and the bacilli being inhaled (for there is always a chance of inhaling tubercle bacilli in a country where consumption causes one-seventh of the total mortality), found a suitable nidus in the wounded epithelium. As this case was not primarily bacillary, the chance for recovery was better, and as it so stands, the patient has recently sent me word that he has entirely recovered, just two years after he expectorated tubercle bacilli.

The changes in the lung substance in those cases is one of so-called chronic pneumonia or fibroid phthisis. The particles of dust act as irritants, and entering the lung substance cause a hyperplasia of the connective tissue, and consequent hypertrophy, so that the alveolar walls, much thickened and hypertrophied, encroach on the alveoli, thus lessening the total amount of breathing space in the lungs, and presenting those symptoms of shortness of breath, etc., peculiar to that condition.

In looking at these cells, there is an inclination to go into the fascinating subject of phagocytosis, as brought forward by Metschnikoff and others, but this would lead to greater length than was intended in this paper.

OBSERVATIONS ON THE FERN GYMNOGRAMMA CHRYSOPHILLA.

J. W. MEEKER, M. D.

THROUGH the kindness of a friend I have recently had the opportunity and pleasure of examining a number of exotic ferns.

That the exquisite grace and beauty of form displayed by many of them should almost entrance the beholder, and quite defy adequate verbal description, doubtless will not in the least surprise those who are familiar with these grand displays of the handiwork of Nature's wise Architect and Builder.

In the fructification of the *Gymnogramma chrysophilla* there are exhibited some striking perculiarities. There are two forms of sporangia, and two sorts of spores. One variety of the former is nearly or quite circular, the other somewhat ovoid in outline. A casual examination of a circular sporangium (taken from a frond and in water) with the microscope and an amplification of from one hundred to two hundred diameters, will give a picture of an ordinary spore-case surrounded by its annulus, and containing relatively few spore grains. A more careful examination, and an amplification of five hundred and upwards will reveal in what before appeared as spore-grains an aggregation of minute particles, simply massed together, and apparently unrestrained by so much as the thinnest envelope.

In the same spore case will also be seen great numbers of elongated, slender, rod-like bodies. I have never found the other variety of spore-case with walls sufficiently transparent to permit the examination of their contents when entire. In ruptured cases, there may be seen the same form of rod-like bodies as were found in the round cases—but no granular masses.

For a still more critical analysis, remove a few of the sporangia from a recent frond and place them on a glass slip in a few drops of water. If necessary break up with dissecting needles a few cases to release the contents, and apply a thin cover-glass. Examine with a good lens having a power of not less than five hundred diameters. If the preparation is a fairly good one, there will be seen vast numbers of rod shaped bodies, both straight and curved, and also small more or less spherical masses, readily suggesting the names bacilli and micrococci. In from one half to one hour's time after the specimen is placed in the water on the slip, there is usually seen a distinct swaying to and fro of the rod shaped bodies—frequently also a slowly progressive and retrograde motion of the rod. If a collection of the before mentioned granular matter be now examined, it will present the appearance of a great number of living organisms massed together and struggling with one another to get free. While one is looking, perhaps a representative little unit will effect its emancipation, and immediately enter upon a free and independent state of existence. Comparing the motions of the rods and granules, the former is relatively passive, the latter very active. The sole object and aim of the active little spherule

seems to be to bring itself into proper relationship with some rod-shaped individual. Several of the granules may occasionally be seen at the same time clinging to the sides of a rod, but they do not long remain in that position. When, however, one has brought itself fairly in contact with one of the extremities of the rod, it is quite likely to remain in that position—speedily losing its identity and apparently becoming fused to the rod.

What is the real significance of this phenomenon? Is it conjugation? Is it the way the rod grows in length? Is it one of the preliminaries to the formation of the prothallus? Will some one kindly tell us all about it?

CYTOLOGY, OR CELLULAR BIOLOGY.

IV.—HISTORY OF THE SCIENCE (CONTINUED).

SECOND PERIOD, 1840–1865.

PROTOPLASM—THE PROPERTIES OF LIVING MATTER—GENERAL CONSTITUTION OF THE CELL.

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DURING the first period little had been done in the way of elucidating the nature of the cell content considered as a living substance. In general it was considered as a liquid or semi-liquid mass, concerning the nature of which little was known; however, the presence of numerous granules and of certain proteid substances had been noticed.

At first living matter was called by various names, such as organizing matter, forming matter, germinal matter, etc. Brisseau-Mirbel called it cambium, a name which had been used by Duhamel; and later Schleiden introduced the name mucus (Schleim) as being found in vegetable cells. In 1835 Dujardin had called the cell-content in Infusoria by the name of sarcode.

As far as can be ascertained, the name protoplasm was first introduced into science by Perkinje. To this view we are led by Reichert who in 1841 makes an analysis of the researches of Perkinje from 1839–40, and expresses himself as follows: "According to Perkinje, there exists no precise analogy between the two organic kingdoms, except with regard to the elementary granules of the cambium of plants and the protoplasm of the animal embryo."

We are well aware that it is generally believed that the term protoplasm has been introduced by von Mohl. We also believe that von Mohl was perfectly honest, and knew not the prior existence of this term when, in 1846, he thus expresses himself in the "Botanische Zeitung:" "I feel myself authorized to give the name of protoplasma to that nitrogenized, semi-fluid substance, colored yellow by iodine, contained in the cellular cavity, and which supplies the material for the formation of the primordial utricle and the nucleus."

However this may be, it is nevertheless certain that it was a happy conception of von Mohl's to use the same term, although unknown to him, in order to indicate or at least to foreshadow the identity existing between the animal and vegetable cell-content.

II. THE PROPERTIES OF LIVING MATTER.

F. Dujardin, in 1835, was the first to make known the properties of living matter. Little was left by him to be added to his discoveries, except probably to generalize and extend his researches to the protoplasm of both kingdoms. The following quotation though somewhat lengthy will give the reader a good idea of Dujardin's notion.

"I propose to call sarcode what other investigators have called living jelly, that glutinous, diaphanous and homogenous matter which refracts light a little more than water, but less than oil; which is elastic and contractile, and capable of forming, spontaneously spherical cavities in its interior, called 'vacuoles,' so as to make a sort of cage with transparent walls. . . Sarcode is insoluble in water; but when left in it for a long time, it gradually decomposes, and leaves a granular residuum. Potash does not dissolve it at once, as it does mucus and albumen, but merely accelerates the decomposing action of water, and gives it a white and opaque appearance. Its properties therefore are entirely different from those of other substances with which it could have been confounded; first, because it is distinguished from albumen in not being soluble in water, and secondly, by its insolubility in potash it is at once distinguished from mucus, gelatin, etc. . . The most simple animals, such as the Amœbæ, Monads, etc., are composed wholly, at least in appearance, of this living jelly. In the higher Infusoria it is enclosed in a loose tegument, which appears to surround it like a network, and from which it may

be almost completely separated. . . We find sarcode also in eggs, in zoophytes, in worms, and in other animals; but then, as it advances in age, it is susceptible of a more complex degree of organization than in the lower scale of animals. . . . Sarcode is without visible organs, and there appears no cellular structure; nevertheless, it is organized, because it possesses the power of extending parts of its body, of contracting and dilating; in a word, it has life."

By the observations of Dujardin a general interest was awakened in the scientific world; and especially among the scientists of Germany. No doubt Dujardin's observations exerted a great influence over subsequent researches. Observations were especially extended into the subkingdom of Protozoans, and as a result we have the beautiful works of Meyen, of Max Schultze, Williamson, Hæckel and of many others cited in the Polythalmes of M. Schultze (1854); in the Foraminifera by Williamson (1858), and the Radiolaria by Hæckel (1845).

Thus the researches of the French scientist were confirmed and extended, and the irritability of living matter was especially brought out. But in spite of the clear statements of Dujardin, sarcode continued to be regarded as proper only to inferior beings, until in 1861 Schultze boldly affirms the identity of sarcode with the animal cell in general, and now there remained only to cross the Rubicon between the animal and the vegetable cell to unite the two kingdoms of Nature by a bond of union—identity of protoplasm in plants and animals.

Whilst the zoologists investigated the physiological properties of protoplasm, the botanists did not remain idle. Already in 1772 Abbé Bonavenatura Corti had observed intracellular circulation, and later many other botanists observed various movements in vegetable protoplasm, as may be seen from the writings of Hofmeister, in his "Treatise on the Cell" (1867). Since then, this movement has been seen in Algæ, in fungi, and their plasmodia, and soon the complete analogy of these movements with those in sarcode was established. This conclusion was arived at through the labors of Nægeli, Cohn, Thuret de Barry, Cienkowski, Wigand, Pringsheim, Schacht, etc., and thus the way had been prepared for the generalizing and the synthetic researches of Brucke (1864), M. Schultze (1863), and W. Kuhne (1864), who demonstrated the complete identity of living matter in the two

kingdoms, with regard to their fundamental physical properties —irritability and contractility. In the beginning of the year 1865 therefore, living matter or protoplasm or sarcode of plants and animals could be defined as "A mass which is diaphanous, semi-liquid and viscous, extensible but not elastic[1], homogeneous, *i. e*, without structure, without apparent organization[2], containing scattered granules and endowed with irritability and contractility."

LEAVES FROM A MICROSCOPICAL NOTE-BOOK,

GREYBEARD.

II.

THE earnest microscopist at work is often under a pressure of fine-adjustment, call it either vibrations, crankism, or whatever you may, which is sufficient to annihilate an ordinary mortal! Even a microscopist is not such an extraordinary being but that at times his refractive index becomes so high or low that his personal equation needs a little adjustment as a correction for this pressure. What greater relief in such cases than a little microscopical nonsense, even if it should be found in a technical journal?—it often calls forth earnest thought according to the individual bent of mind of the reader, leading to valuable results in science. Who but the reader of a microscopical journal can so well appreciate and have as expressive a smile over the fact of the non-technical press making an old man "resolve a pustule of *Ampliplura pellucida* with the one-sixth of a wide angle *objection!*" Is it not time the schoolmaster should be abroad among the microscopical heathen? In passing, let me state in response to several inquiries, that the old man on the cover of Bausch and Lomb's catalogue is not "Greybeard." Although ugly enough to be he, "taint a bit like," for he never squints one eye up, in imitation of a green persimmon pucker, while peering down the tube with the other; and surely here is a fact sufficiently "wise" to offset the "otherwise" of this bit of information. Let the young microscopist make note of this fact, for it is one that will even unbend a starchy professor to the extent of admitting its value, although he may anathamatize the setting of the jewel. The effort of keeping the unused eye closed has a

1 Dujardin had called it elastic. We shall see later whether there is any reason why this statement of Dujardin's should have been rejected.
2 Dujardin maintained that it must be organized.

sympathetic action upon the eye over the tube, equal to the blurring out of fine detail, especially in work demanding the use of lenses of high resolving power. Keeping the other eye open is one of the very important "little things" in microscopical manipulations.

While the microscope may never reveal the form of a molecule, still the microscopist should educate himself to feel optically its vibrations. Aye, more. The writer has a $\frac{1}{6}$ adjustable, homogeneous immersion objective of 1.43 N. A., with which, when the "personal equation" is just right, he imagines he can almost optically feel the "inter-vibrations" of an atom! It seems a sentient thing, a part of his very inner self. Under present light I would not exchange this lens for the latest apochromatic. Four years ago, by light from my diaphragm lamp with no other aid than bull's eye and mirror, it convinced me that the transverse striæ on *Amphiplura pellucida* are formed by oval beads, length-wise of the transverse striæ of the frustule. I have never entirely separated these beads, yet, I have so greatly narrowed the connecting link that I can readily believe them separated. I know no objectives superior to those of American make.

In "spirito" I know no past except it be the infinity anterior to "Ea archa," hence no inconsistency in my speaking of my ancient friend, Got-Thothi-Aunkh, as a present associate. He appeared on the earth nearly 950 B. C.; a priest (?), architect, and of royal Egyptian blood, as evidenced by the leathern cross on his thorax, with four seals thereon of Osorkon III. Enter the Museum of Tulane University of New Orleans, La., take a few steps forward and to the right, and you will feel yourself physically and psychically present with him. Small samples of each vestment in which he has been clothed for nearly 3,000 years have been in my microscopical den for two months, undergoing treatment, and microscopical examination, with specimens of the fibre teazed out from the cloth. A difference of opinion existing as to this fibre, rather stirred up my microscopical mettle, and for two months I have been under the pressure of work in making an exhaustive and final settlement, with proof, as to the cloth in which Got-Thothi-Aunkh was embalmed. After over a thousand examinations and two hundred mounts, I find no fibre but that of linen.

The young microscopist may think that eight to twelve hours

daily for two months is a long time to decide the fibre of an old rag! Remembering that the Egyptian method of embalming is to a great extent a lost art, let him take a piece of this cloth, some of which is as brittle as $\frac{1}{500}$ inch cover glass, and treat it with different solvents till in a condition for teazing, being ever guarded not to vitiate structure by these solvents, and perhaps he will find himself in a fog at the expiration of twice two months; a good lesson about carefulness in "little things."

As a relief to the pressure of the past two months, and they have been hot ones, I have occasionally written a so-called nonsensical letter to some microscopical brother or sister, the replies to which have been far from nonsensical although containing some facetiæ. I violate no microscopical or social confidence in quoting from one very pleasantly written reply, as follows:

"That mummy business interests me exceedingly. Where did you get him and what in the world are you learning from him? Can he throw any light upon the building of the Great Pyramid? Are there any epithelial or endothelial cells still recognizable. Any traces of protoplasm or blood corpuscles? What did he die of? Remember the story of the grain of wheat found in a mummy case that sprouted and grew; and beware of the disease germ."

"How strange to find those pictures of which you write. Are they crystalline? What was next the slide in the microscope box?—No, I am not superstitious, yet I believe I had just a little rather see the new moon over my right shoulder. If there is any supernatural manifestation there, depend upon it the mummy is at the bottom of it, or had a hand therein. Now remember, my advice is don't get on too familiar terms with that old party."

The pictures referred to had their origin in two or three minute drops of an aniline solution used in coloring the sherbet that caused the death of Miss D' Homecourt of New Orleans. Such was the chemical and legal decision. I was in no way connected with the case, but for my own edification made a microscopical examination of the dried aniline solution, to see if there was sufficient of the arsenious acid to be revealed by the microscope. There was an abundance of minute crystals, in form and size apparently identical with those from a dried solution of pure arsenious acid. Although willing to swear to the identity of some

special blood corpuscles under given conditions, yet when the identity of arsenious acid is called in question, the writer depends upon chemical reaction; still, in this instance the writer considers his unauthorized microscopical examination of this aniline as strongly confirmatory of the authorized chemical analysis made by Dr Johnson, chemist of the Charity Hospital, New Orleans.

The slide of aniline was placed in my cabinet, remaining there for six weeks, when, having occasion to refer to it, instead of two or three dots of aniline I was confronted with a picture about $\frac{1}{4} \times \frac{3}{8}$ inch in size, very plainly revealing a death's head and the head of an old man with long beard and hair, either appearing in the same place, dependent upon the direction of the light. The specimen was not mounted till after this revelation, when I made a second dry mount of it in hope of preserving it as a curiosity, not as a freak of Nature, but the result of some physical law yet unknown to science. The specimen is still intact, and is open to inspection. I am not a so-called spiritualist, nor do I believe in the so-called supernatural. That an image of an old man should appear, as if photographed in iridescent colors, I do not think beyond the bounds of present scientific explanation, but the skull forces me to the wild query, "Are we yet to discover a physical law by which it may be proved that thought acts upon matter?" If so, the skull can be accounted for.

Perhaps it will not be microscopically irrelevant for me to make the personal statement that I believe Mind to be the emanation of God within us, relegating all else to Energy and Matter, awaiting with an ever onward effort in behalf of the advancement of science though the gathering be but a drop at a time.

Returning to matters more closely connected with microscopy, perhaps a word about a hap-hazzard mounting cement may interest some one. Using the microscope more than the mounting table, it once so happened that I was out of white zinc and other kindred cements. An unexpected emergency for some mounts placed me in a dilemma; especially so as I was on a plantation, out of reach of a dealer. Necessity whetted my wits thus. Scraping the waste debris from a lot of varied cement bottles I dissolved the same in benzol. After filtering, and evaporating to proper consistency it proved to be the best mounting cement I have ever used; almost coming up to the standard of an

ideal cement for general work. I attribute its excellence mainly to a process of atmospheric oxidation which my crude material had been undergoing for years. The filtering while very thin, through both cotton and thick filtering paper, removed all solids of which benzol is not a solvent. There are many little experiences in microscopy which are never mentioned simply because "Oh, any body would think of doing that!" During a long microscopical life the writer has suffered divers vexations of spirit from ignorance of a "little thing" in mounting; so very little, indeed, that it seems as if every one who has made a balsam mount must know it; as yet I did not till a month ago. Let us have more of the little things in microscopical work; everybody does know everything.

TURN TABLES.

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AMONG the mechanical devices employed by a large proportion of those who work with the microscope is the turn table. In referring to the instrument one of the prominent microscopists of the present day says; "These turn tables are as nice and neat and beautiful as can be imagined." To all of this I agree, but what is of still more importance is the fact they are more convenient, useful and necessary, than can be imagined. I do not think that those who mount specimens and finish the slides off without the use of the turn table can imagine how useful it is, or each operator would immediately purchase one. I am of the opinion held by the editor of the *American Naturalist* in 1876 when he wrote: "If the real convenience of the turn table were known it would soon become general."

All the turn tables of the present day consist essentially of a disk supported on a perpendicular axis so that it can be easily and rapidly rotated. A hand rest is attached for the purpose of steadying the brushful of cement, while it is applied to the glass slip which can be temporarily fastened to the revolving disk. The first turn tables, which were made about twenty years ago, had the disk supported on a blunt rod, but as the man of the stone age learned to sharpen his weapon, so the manufacturers have found that the disk will turn more readily if the rod is pointed.

In looking over the price lists and catalogues from the various dealers in microscope accessories, I find the following formidable list of turn tables are on the market; Shadboldt's with wood base, same with centring adjustment; Cox's improved self centring; Standard; National, plain and self centring; Griffith's self centring and decentring combined; Queen's comfortable turn table; Kinne's self centring; Congress self centring; Beck's; Watson's plain and self centring; National, volute, and probably several others which I have not seen.

According to the price, turn tables are divided into two great classes; self centring and plain. By self centring is meant that a slide which has been ringed on the turn table can be again placed in exactly the same position without trouble. This is a convenience when more than one coat of the cement must be applied to a cell. In the mounting of opaque objects and all substances requiring deep cells, the self centring arrangements will be highly appreciated. I have found that the slides in the market of average quality are not perfect rectangles, so that the slide must be replaced end for end the same as before, in order to have the entire benefit of the self centring apparatus. This can be accomplished by marking one side of the turn table disk with a file or by spotting it with cement. Then place the end of the slide bearing the label, or some special mark, towards the mark on the disk. An observence of this simple rule will save much annoyance in retouching or finishing off mounts. I would suggest that manufacturers make the disks with a mark where one end of the slide is placed.

The decentring turn tables are so arranged that a slide finished off on a plain table can be readily brought into position and retouched. I have found this device of great convenience when fixing up old mounts or those injured in transportation. The Griffith turn table has the best decentring arrangement that I have ever used.

Do not hesitate, in selecting a turn table, to purchase a self centring and decentring one, if it can be afforded. At any rate get one that has a heavy disk and a substantial hand rest so that the instrument will set firmly on the work table and the disk will continue to revolve for some time. A smooth ring of cement cannot be made if the brush touches the slide while the disk is at a stand still, or moving slowly. The light turn tables with thin

narrow disks are valueless; the body of the turn table should be supported on legs and not rest on a block of wood; otherwise it will not be steady. The patent removable hand rests sold with turn tables may bring a profit to the manufacturers, and I should think they would judging from the prices asked, but to the microscopist they are only in the way. If the turn table is placed directly in front of the operator, parallel with the edge of the table, and the worker sits squarely up to the table, there will be no need of a removable hand rest. It is very important to learn in the beginning that good work requires that a person shall sit well in the chair and with full face to the table, and then place the turn table as just stated. It is almost agonising to see how some persons persist in balancing themselves on one corner of a chair and attempt to direct the turn table toward all points of the compass at once. When the operator and instrument are both properly placed the brush must be held in the hand after the manner of a pen, only it must make a more obtuse angle with the slide than the acute angle a pen forms with the paper What is also of importance is to remember to have the brush touch the slide at the point in the imaginary ring which is furthest from the operator. That is in a manner so that the brush point the centre of the ring and a point in the median line of the operator will form a line.

My advice, based upon experience, is to avoid those turn tables which have a spring self centring apparatus, as the spring will soon wear out and leave the table only a plain one. Clips are a convenience on any turn table, and I hope that some of the heavy and light running turn tables which are now made without them will soon be supplied with this convenience. When the disk does not turn readily, or attempts to make music, it can be remedied by removing it and washing both spindle and socket with benzol or benzin.

My greatest and in fact only objection to turn tables is the exorbitant prices charged for them. Still I do not see how any microscopist can afford to work without one.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

THE USE OF THE MICROSCOPE.

AN AMATEUR.

XVII.

DO not handle the mirror too daintily; if well mounted there is little danger of injuring it, and a firm grasp makes it more easily manageable. At first there will probably be some difficulty in illuminating the field as it should be illuminated, but a little practice will accomplish it. The entire circular space called the field should be evenly lighted; there should be no shadows nor faintness in the glow near the edge. Some writers recommend that a piece of tissue paper shall be placed over the stage-opening and the mirror manipulated until the light is thrown exactly in its centre; it is then removed and the light of course passes through the objective and up the body tube. This is a good plan if the reader has trouble in seeing where the reflection is thrown, but usually the light may be observed on the front of the objective. The field can scarcely be illuminated while the eye is at the eye-piece; the illumination may then be completed, but not begun. The only plan is to use the paper on the stage, or to observe when the front lens receives the light. Then apply the eye and gently manipulate the mirror, trying to improve matters; but even now the best can not be obtained. This must wait until the slide is on the stage, when the body is carefully racked down and the focus obtained as previously directed. It is possible that the field may then be evenly illuminated, but too faintly to show the object properly, or oblique shadows may be thrown across it, or only one little space at the side may be bright while all the rest is semi-obscure. This must be remedied by gently moving the mirror, while eye is at the ocular. When all the circular region is lighted as well as seems possible, remove the eye-piece and centre the illuminating beam by the method suggested by Mr Edward Pennock and described on a preceding page. Then with the eye-piece again in position, the field should appear brightly lighted in every part. It will probably be too bright, and the observer must either rack down the condenser, if he uses one, as he should, until the desirable softness of illumination is obtained, or the same result is to be worked for by rotat-

ing the diaphragm. Here the observer will have an opportunity to exercise his judgment, for this is one of those things that cannot be described; it must be taught personally, or discovered by the worker unaided.

To the use of the mirror in this connection certain rules apply. With very low power objectives where the actual field is comparatively large, the apparent field cannot be evenly lighted by either mirror. With all low powers, and without a substage condenser to modify the intensity, it is better to use the plane mirror. This will sufficiently illuminate the field of all below the one inch, until we reach those very low powers now used, such as Zeiss's variable A* which may be used as a three or five inch, with all intermediate amplifications, by simply turning an adjustment collar. The field of these lenses cannot be lighted throughout its whole extent by either mirror. The concave gives only a central bright spot while the plane surface does little better. To light this large region fully, the plane mirror should be covered with a disk of white card-board, and parallel rays thrown on it by the Bull's eye condensing lens. The mirror and card are then manipulated as the mirror alone should be. Or a more successful result may perhaps be attained by taking the light with the mirror from the brightly illuminated inner surface of a white lamp-shade. With the two inch or the one inch the plane mirror alone is sufficient. All higher powers demand the use of the concave surface unless the Bull's eye lens is placed between the lamp and the mirror, with a substage condenser between the mirror and the object; or unless some form of microscopical lamp is used with a permanent Bull's eye lens in which cases the plane surface should be turned toward the condenser.

It sometimes happens that if the microscope has travelled for some distance by railroad, the owner will have trouble to get rid of a broad, cresentic shadow in an otherwise well lighted field. No manipulation of the diaphragm or other substage appliance serves to remove the annoyance; it remains partly eclipsing the field by its region of darkness, and the beginner may think that something serious has happened. The trouble is caused by the jarring of the diaphragm in the body or in the draw tube, the journey having shaken it too far downward. Remove the body, first of course taking off the objective and the eye-piece, and push the diaphragm up a little way, repeating the operation if not at first successful.

If the stage bears spring clips, the slide will be placed under them, with the object to be examined directly above the stage opening so that it may be lighted by the mirror. It is then moved about under the clips by the fingers, the slightest movement being magnified and appearing as something great, when seen through the instrument. This finger manipulation is exceedingly awkward at first, not only because the fingers have not been educated to such work, but because every movement must be the reverse of that which appears to the eye to be demanded. If the object seems to need moving to the right the slide must be pushed to the left; if it seems to demand an upward movement, it will appear to travel in that direction when the fingers pull it downward. But these little things are soon learned, and the fingers will speedily make the correct amount of pressure and in the right direction, with no conscious stimulus from the mind. It will become automatic, and so cease to give trouble. At first, however, the beginner must expect to see the object fly out of the field more than once, before he learns to master his fingers. This reversal of the movements is needed with all stages, even with the mechanical, but with certain movable stages like Mr Zentmayer's and others, the slide is simply laid on the surface where it remains in position by its own weight, and the stage is moved by the educated fingers, or the fingers that soon become educated.

These movements of course apply to all objects, opaque as well as transparent, but the illumination of the former must be modified, as they cannot be studied by transmitted light. To examine them they must be illuminated from above, the concave mirror being swung over the stage, and the light focussed on the surface of the object, or if the Acme lamp is used, the Bull's eye lens on its front may be employed without the mirrror. In this way many apparently unattractive opaque objects become exquisite or gorgeous. The reader, therefore, should not neglect this method of illuminating and of studying substances that may appear not worth the trouble. The unexpected revelations of the microscope are among its greatest attractions, and the unexpected revelations of beauty in an object not charming to the naked eye is a wonder that never ceases.

IT was with considerable surprise that the writer learned that there is a distinct disease of the roots and subterranean stems of certain plants in the southern part of the country, caused by the presence of an *Anguillula* within the tissues, a worm closely related to the paste worm and the vinegar eel. An interesting paper on the subject has recently been published in Bulletin No. 20 by the Department of Agriculture, and finely illustrated with twenty-one plates. It is written by Dr J. C. Neal of Florida.

The disease, according to Dr Neal, is exclusively restricted to the southern part of the country, never having been observed further from the limit of tide water than one hundred and fifty miles, so that southern microscopists have this field for investigation entirely to themselves. The affection manifests itself in what is called the root-knot disease, and is characterized by the presence of irregular enlargements on the rootlets and underground stems, in each of these swellings an *Anguillula* usually being found as the cause. It had been recognized as a disastrous disease for many years, indeed, according to Dr Neal, since the earliest settlement of the South Atlantic and Gulf States by the whites, but the true cause was not suspected until Dr Neal sent specimens to the Department of Agriculture, and was requested to investigate the matter. This pamphlet is the result, and while, owing to the difficulties of the subject and the limited time at the author's disposal, the results are not so complete as is desirable, still the comfort remains that there is much for the amateur microscopists in the southern States to do. They have the diseased plants at their doors. They need only to go out and pull them up by the roots, and proceed to investigate the cause which they will find snugly tucked away in the root-knots.

Many common wild plants are affected, but the depredations of the little worms seem to be chiefly confined to those that are cultivated, of which Dr Neal gives a long list. The disease

manifests itself by the presence of knots on the roots with their subsequent decay, and "the plant stops growth, the fruit either becomes destroyed or drops prematurely, the leaves change color and fall off, and the plants die so rapidly as to justify the usual expression, 'struck by lightning,' applied to the fields of melons, cucumbers, tomatoes, and cow-peas so often badly affected by the root-knot."

The *Anguillulæ* are strong enough to enter the stomata, or breathing pores, active and strong enough to penetrate even the cell walls, or to separate the cells in loosely connected tissues. Once within, continues Dr Neal, they could easily pass to any portion of the root, and it is not unreasonable to infer that in this manner they obtain entrance in young rootlets.

Much remains to be learned relative to their life history, and if the microscopists of the southern States are in need of microscopical work which may bring not only renown to themselves, but perhaps help to the stricken plants, this seems to be an important field, and one that may be useful to the whole country which looks to that part of the land for so many of the fruits which this little *Anguillula* is in a fair way to destroy, unless our southern friends can unravel its life history, and point out a remedy that shall protect the shrubs and trees from its devastations. The disease, says Dr Neal, is found in wet, sandy locations along the coast of Texas, and not at all in other regions west of the Mississippi River; but eastward it is progressively worse until it reaches its climax in Florida, where its ability to do mischief in gardens and groves is exceedingly great.

Dr G. F. Atkinson in the *Journal of the Elisha Mitchell Scientific Society* also publishes a noteworthy paper on this subject, detailing more of the worm's life history and habits. Although these two authors have greatly increased our knowledge of the parasite there is still much to be done. The subject forms an important field for investigation. Let the southern microscopists get to work. They have no time to lose.

ACKNOWLEDGMENT.—To Prof V. A. Latham, Ann Arbor, Mich., for a section of diseased lung to show her method of mounting. —To Prof Wm. Lighton, Atchison, Kas., for a section of vegetable ivory for the polariscope.—To Mr Fr. Dienelt, Loda, Ill., for the tracheæ of a lepidopterous larva with internal hairs arranged

and confined in broad encircling bands. Also for slides of trachea from a beetle, the larva of the hickory borer. etc.—To Dr J. Edw. Line, Rochester. N.Y., for photo-micrographs of living *Tubifex*.—To Dr Wm. N. Beggs for sections of testis and of lung of chicken and a section of human kidney. These are all well cut and mounted, but the section of kidney is one of the best and most instructive preparations of the kind that I have ever seen. The epithelial cells within the uriniferous tubules with their large nuclei are beautifully displayed, but the capillaries forming the glomeruli are emphatically conspicuous and are naturally injected with their own blood, the corpuscles still remaining *in situ*. The same may be said of many of the transverse and even of some longitudinal sections of the larger blood vessels. The preparation has been skillfully made and is exceedingly instructive. Also for a section of rat's liver showing the very rare formation of tyrosine crystals. This is in lustrous, needle-like crystals, in many instances collected in clusters and radiating masses. Aside from the beauty of the crystals, the slide possesses more than ordinary interest as a pathological specimen.

NEWS · FROM · THE · WORKERS ·

STRUCTURE OF THE DIATOM VALVE.—Two remarkable papers on this subject, one by Mr T. F. Smith, the other by the Hon J. D. Cox, appear in the April number of the *Journal of the New York Microscopical Society*. The following is a résumé of these essays.

Mr Smith's paper opens by correcting some of the conclusions he had made public in reference to the structnre of the Diatom valve in a former paper of his read before the Quekett Club in September 1888. He thinks that the use of the apochromatic lenses with the illumination of a very wide cone of light from the achromatic condenser enables him to reveal by photography the following new points in the structure of *Pleurosigma formosum*:

1. The shell has three layers which may be discriminated by

careful focussing and illumination. 2. The inner layer is nearly flat and consists of "a square grating set lengthwise of the valve," the alternate squares being red, with the intervening ones white, the white becoming green and the red white with deeper focussing. 3. The middle layer is also a grating of bars of silex crossing each other nearly at right angles, in other words a plate with approximately square perforations, the grating set obliquely to the length of the valve. 4. The other layer is made up of fibrils running the whole length of the valve, each pair separating and meeting, alternately, so as to pass round each dot in the middle grating, and when separated from the shell, the fibril appears like rectangular blocks of silex attached to each only by the corners.

Mr Cox presents the present state of our knowledge with regard to microscopical vision and the interpretation of microscopical images. He also sums up the accepted ideas as of the structure of the Diatom shell, showing that the new points presented in Mr Smith's paper are: 1, the asserted existence of an inner tessellated plate having squares showing alternate colors under the microscope, and twice as numerous as those in the middle layer lying immediately above it: and 2, the outer coat of fibrils (silicified) running so as to leave openings above the "dots" or alveoli of the principal plate.

As to the first of these, Mr Cox argues that the known phenomena of diffraction and of microscopical definition will perfectly account for the appearance of Mr Smith's inner tessellated plate, the red squares being caused by the solid area of silex in the interspaces between the alveoli, the latter being approximately round, arranged in lines nearly at right angles to each other. The green or white spots he regards as the true alveoli.

As to the fibrils, however, Mr Cox thinks that the photographs sent by Mr Smith demonstrate their presence in the specimens from which the photographs were taken, the decisive fact being that some of them have been floated off and lie beside the shell which has similar ones *in situ*. Whether this is a peculiar state of the specimen which might be seen with ordinary objectives, or is a revelation due entirely to the apochromatic lenses, Mr Cox thinks deserving of further examination.

POLARIZING WITH A SINGLE NICOL.—I made a discovery the other day which after all may be an old thing. I can polarize with only one Nicol (as analyzer), the *conditio sine qua* being a blue sky, especially the day after a rain. For greater convenience I have extemporized a holder for the analyzer which I slip over the eye-piece. Starch "crosses" very distinctly, but of course fainter than in regular polarization. For color, I put the selenite on top of the slide; the colors are also somewhat fainter. The selenite is effective anywhere, so it be placed beneath the analyzer. This comes handy in two ways: 1. It is possible to get polarizing effects with a stand not provided with a substage. 2. When in the course of examination we want to see whether the object will polarize, the Nicol slipped over the eye-piece will quickly tell us whether it is worth while to apply the polarizer in the regular way. But with any other sky than a blue one, the trial will be a failure. With ordinary lamp light I succeeded in getting faint indications, due of course to the position of the mirror.—HANS M. WILDER.

A RE-AGENT BOTTLE.

E. B. KNERR.

A very inexpensive yet very serviceable re-agent bottle may be made as follows:

To an ordinary ounce or half ounce bottle with wide mouth, a suitable cork of wood or rubber is fitted. Through the cork is passed a piece of glass tubing $\frac{1}{4}$ inch in diameter and of sufficient length to reach near the bottom of the bottle and yet extend $\frac{1}{4}$ to $\frac{3}{8}$ inch above the cork. Over this $\frac{1}{4}$ inch slip a piece of $\frac{1}{4}$ inch rubber tubing about $1\frac{1}{2}$ inches long, and close the upper end by inserting about $\frac{3}{16}$ inch of the core that was removed from the cork by the cork-borer. The lower end of the glass tube should be drawn out to a narrow opening. The glass tubes may be made by softening a piece of tubing over a spirit lamp or gas flame and drawing out. It is convenient to make a num-

ber at once by narrowing the tubing at proper intervals and cutting with a file. The sharp edges of the glass should be rounded off by softening in the flame. In use the tube is filled with liquid by compressing the rubber and then relaxing while the narrowed tip is immersed. On removing from the bottle and again compressing the rubber the fluid may be delivered in such quantity and just where desired. I find this bottle especially serviceable in washing, staining, and clearing sections or objects that are fixed to the cover glass rather than to the glass slip previous to immersion in the mounting fluid.

By the way, I find the method of floating objects on the cover glass, staining, arranging, etc., so much more preferable to the old methods that I wonder is not more recommended. In mounting a section of kidney, for instance, I remove the section from the 50 per cent. alcohol solution to a watch crystal filled with distilled water. The alcohol in the section causes it to float out perfectly straight on the surface of the water. I have ready a cover-glass in a watch-spring clamp and lift out the specimen on the glass without the slightest pucker or ruffle. A few drops of staining fluid may now be added from the dropper above described, and the cover glass laid on a plate under a watch crystal or bell-jar. When the stain has set sufficiently, the excess may be drained off, the specimen washed by slightly inclining the cover glass and using the dropper. The preparation is then dried by holding in the fingers over the flame, a drop of turpentine added from its dropper, the excess drained or absorbed at the edge of the cover glass, followed by a drop of balsam. The cover is then inverted and lowered to the centre of the slip.

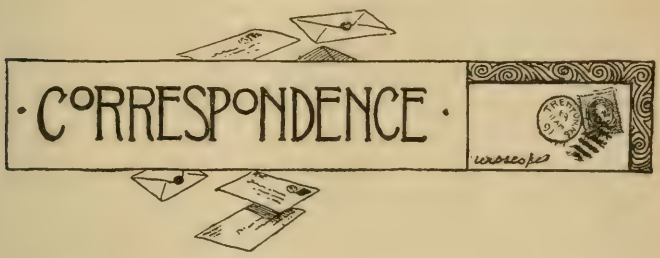
CIRCULATION IN THE LIVER-LOBULES.

DR M. F. WEYMANN.

In examining the liver of a rat I recently made the observation that the circulation of blood in the viscus can be watched almost as well as the blood stream in the web of a frog's foot. A few trial repetitions developed the fact that the liver to be examined must come from an animal killed without the loss of any blood, that the hepatic vessels must be tied before removal, and the portion to be examined should come from near the surface. It is not necessary that the organ be entirely fresh, for a specimen

taken from a potassium bichromate solution (weak) after four day's immersion showed the appearance very nicely.

Prick, with a teasing needle, a small part of tissue from the gland. In size it should not exceed a millet seed, or three times the mass of the head of a pin. Add some indifferent fluid such as "artificial serum" or a weak salt solution (5 per cent.). Put on large sized cover glass and examine with a $\frac{1}{2}$ or $\frac{1}{3}$ inch objective. Very gentle pressure on the cover glass will reveal the flowing blood which, on stopping the pressure, actively rushes back to a central opening (the intra-lobular vein), all the little blood channels appearing like so many radii gathering into it. Sometimes a repetition shows beautifully what a previous effort failed to obtain.



EDITOR THE MICROSCOPE:—

In the December number of THE MICROSCOPE, "An Amateur" writes: "On no account would I give an intelligent beginner a stand with a short body tube." I wonder if he really intends to advise an intelligent beginner to select an instrument with a single long tube in preference to a short main tube with a draw? In the same paper he writes that on no account would he give a beginner a stand with a single eye piece. He will find much criticism unless he can give some good reason for his advice. Many would prefer the following: First select a good stand with low eye piece, and then the best objectives obtainable with sufficient power to accomplish the work desired, bearing in mind that increased power should always be secured by suitable objectives in preference to deep eye piecing for the reason that any defect in the objective will be magnified by the ocular.

"Amateur's" exact meaning of "Buy one with what seems to a multiplicity and a complexity of movable parts" is not clear.

It seemst hardly probable that he intends to advise an "intelligent beginner" to purchase an instrument for work, provided with a mechanical stage with levers and thumb screws by the dozen, with a substage having a complexity and a multiplicity of movable parts, requiring a post-graduate course to understand them. Neither is it probable that he would seriously advise all of the reflex and duplex and complex accessories devised for revenue only.

Such microscopes are the result of rare inventive powers and to "impress the jury," they may have a value (?) but during a period of nearly a quarter of a century, while visiting the larger cities of our Union I have never yet found a microscopist who had much use for such an instrument. True, some of our best workers own one and they take pride in showing it as they would a diamond pin. Such microscopes are usually found in the mansions of the rich, placed on a beautiful marble topped stand and covered with a bell glass, which for fear of dust is seldom removed. The rich owner receives the name of scientist while in reality he may not know an objective from a tube cast.

On page 3, of Prof Leidy's report, that eminent microscopist informs us that all of the microscopical work in that volume was accomplished by the use of a microscope costing less than $100.00, and among those who have taken the time to read of the life work of our scientists who have been in the front ranks, it is a well known fact that only instruments of the simplest construction have been used. If "An Amateur's" advice had been limited to the one list given by him, possibly no one would complain, but the instruments included in that list do not, "require both hands to push them about the table top," as does his model stand.

I know of no one who would endorse An "Amateur's" instructions to reject the two "lower grades of objectives usually furnished," and to take a one inch of higher grade instead. Poor objectives should never be chosen, but the moderate priced lenses usually provided with first-class stands are a credit to the manufacturer, and I am very willing to place myself on record as advising the selection of the two objectives under consideration in preference to those of very wide angles for general work.

I am unable to identify "An Amateur." He gives advice with all the confidence of an expert microscopist with a long lifetime

of experience, but that is common with amateurs, and as many of his notes seem to indicate a lack of experience, it may be well to give him the credit of signing his real name. Were it not that many are liable to be misled by reading his instructions from the pages of a widely circulated and popular journal of microscopy, we might read and be silent, but errors should be corrected if possible, and in this article I do not wish to be understood as giving my opinions only, but those of the majority of the many hundreds of microscopists whom I meet in my travels each year.

"An Amateur" writes that the greatest objection to most of the stands is the absence of space about the stage. He then advocates large stages, and surely they have not so much space about them as the smaller ones. I think it safe to assert that out of every one hundred slides there is not more than one that is larger than 3x1 inches, and a stage two and one-half inches in diameter is plenty large enough for such slides, and much more convenient. It will allow the ends of the slide to project so that the index fingers of each hand may control it in a more satisfactory manner than in most cases can be done by the use of a mechanical stage costing $30, and in focussing for high powers the nearness of the objective to the cover glass may be determined by tipping the slide a trifle.

Those who make small stages do so because they believe them to be the best, and were a vote taken to-day of all the expert microscopists in America, I have reason to believe that the majority would be in favor of small stages. There are those engaged in work which may require large ones, but I have found very few, if any. A small stage will certainly be more convenient in connection with the sub stage and its accessories, while a large one with a low stand would be very much in the way.

"The microscopist's fingers need all the room possible in manipulation." It is much more convenient to work by the side of a table than it is to sit on top of it. "An unsteady instrument is unpardonable" will secure the endorsement of every worker, but that a great microscope stand requiring the use of two hands to move it about the table, is steadier than a much smaller one equally well made, I do not believe, and I have the same opinion in writing by many eminent microscopists whom the world delights to honor.

The day for timbers two feet in diameter in the frame of a house, and for the excessive weight and clumsiness in microscope stands has passed. Microscopists do not overturn microscopes. The firmness of the stand under manipulation depends above all on the perfection of the fitting. When in 1886 an earthquake rocked the great Southern Hotel in St. Louis so that I and other frightened guests left our rooms in haste, it was learned that in some of the smaller surrounding buildings, the earthquake had passed unnoticed.

In conclusion I wish to be understood as being an advocate of stands with a draw tube and with a single low power ocular for work, with not less than two good objectives and without a "complexity and a multiplicity of glass and brass." I would advise the purchaser to secure all information possible and then to use his best judgment, as extra power cannot be secured by tubes of great diameter and by a large stand with showy accessories. I desire to be placed on record as an advocate of so much only of "glass and brass" as will aid in securing the best results with the least display.

It is my firm belief after years of personal experience and association with microscopical societies from the Atlantic to the Pacific, that a well-made medium-sized stand with a small stage is much steadier and much more to be desired than one weighted down with "brass and glass and with a multiplicity and a complexity of parts."

If any persons in reading this communication discover that it in any manner describes an instrument in which I may have a personal interest, he will understand just the reason why that instrument was so made.

It would be of great interest and of much practical value to all parties interested if a friendly exchange of opinion could be given to our scientific journals, and I trust that even "An Amateur" will not be offended, but will be willing to receive as well as to give.

After a residence of more than twenty-five years in Fairport, N. Y, I am now moving to Rochester. My new address is given below.

E. H. GRIFFITH.

28 MEIGS STREET, ROCHESTER, N. Y.

THE MICROSCOPE

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ORIGINAL COMMUNICATIONS

THE MICROSCOPE AMONG THE MOSSES.

S. W. COCHRAN.

THE mosses, though not so frequently studied by amateurs in botany as the more conspicuous flowering plants, are yet wonderfully interesting, and will well repay in interest and instruction any labor which the student may bestow upon them. The belief is commonly entertained that they are much more difficult to study than the flowering plants. It is true that the microscope is an essential requisite, and very little can be done without its assistance, but to those who have some familiarity with microscopical manipulations the mosses will present no greater difficulties than the higher orders of plants. One of their peculiarities, and one which is very convenient for those who have but few and irregular opportunities for botanical pursuits, is that it is not necessary that they should be examined while fresh. They can be laid carelessly aside for weeks or months if need be, and a few moments' immersion in water renders them (except in a few special cases) as fit for examination as when freshly collected.

The purpose of this paper is merely to present a summary of the leading features of the structure, growth and reproduction of

the mosses, for the convenience of those who have no previous experience in their study. The more advanced student will have recourse to such works as Bennett and Murray's Cryptogamic Botany, Bessey's Botany, Strasburger's Vegetable Histology, etc., (from which many portions of this paper are taken), for information in regard to the structure and physiology; and to the Manual of Lesquereux and James as the best available standard in respect to the classification.

Mosses are found in almost every part of the world from the coldest to the hottest, though they are most abundant in temperate regions, where they are everywhere to be found, flourishing most luxuriantly in damp localities. They are mostly aerial plants, growing upon moist earth, the trunks of trees, decaying wood, rocks, etc., a few species in water. As is well known, they are small in size, varying from less than $\frac{1}{25}$ inch to several inches in height, the usual height being from one to two or three inches. They are generally bright green in color, occasionally whitish or brownish, and all contain chlorophyll. The mature plant consists of a leafy stem fixed to the soil or other support by root-hairs or rhizoids—mosses have no true roots. These rhizoids are branched, articulated filaments which spring from the outer layer of cells in the stem, often completely covering its lower portion with a brownish, matted, felt-like mass. The leaves are small, sessile, varying in shape from linear or narrowly lanceolate to broadly ovate or almost orbicular, and usually inserted somewhat obliquely on the stem in two or three straight or spiral rows. They consist generally of a single layer of cells, and are either nerveless or traversed lengthwise by a midrib or costa, in a few species by two.

The plants of the class *Musci* (which includes the Mosses and Liverworts), seem to form a kind of connecting link between the vascular and non-vascular cryptogams. Although they contain no true vascular tissues, yet in some genera (*Leucobryum*, *Barbula*, etc.), there is a differentiation of the tissue of the stem into an inner portion, composed of large thin-walled cells, (parenchyma), and an outer portion, consisting of one or more layers of thicker-walled cells, partaking of an epidermal character and forming a kind of imperfect sclerenchyma. In other genera (*e. g. Funaria*, *Mnium*, etc.), the differentiation of structure is still more evident. If we make a cross-section of the stem of

Funaria, by embedding in elder-pith or other suitable material, and examine under the microscope with a moderate magnification, we find in addition to the outer layer of thickened cells and interior large-celled tissue, a central bundle of very narrow thin-walled cells, usually not sharply defined. "This central bundle is said not to possess any of the strengthening functions of a true vascular bundle, but to serve merely for the conduction of water. Its cells contain nothing but a watery fluid without starch grains, oil, or protoplasm. In genera which have no such central bundles, like *Dicranum*, or *Leucobryum*, the epidermal tissue of the stem and branches with its perforated cells, forms a similar capillary apparatus." If we examine a similar cross-section of the stem of *Polytrichum* we find that the cell-walls of the central bundle are not only much thicker than in *Funaria*, but that there are also extra-axial bundles, and in some cases bundles of thin-walled cells have been found passing obliquely through the stem, connecting the leaves with the central bundle; thus showing an increasing tendency to specialization of structure, and indicating that the mosses undoubtedly possess rudimentary fibro-vascular tissues.

The beginning of a leaf is a broad papillose bulging of a cell of the stem, which becomes divided from the parent cell by a septum, and continues to grow and subdivide until the full-grown leaf is formed.

If a leaf of *Funaria* be cut or scraped from the stem, and placed in a drop of water under the microscope, it will be seen to consist (excepting the margin and a band lengthwise through the middle), of a single layer of cells, all of which contain chlorophyll grains. This leaf will illustrate the general structure of the leaves of mosses, most of which consist principally of a single layer of chlorophyll-bearing cells. In the *Sphagnaceæ*, however, and in *Leucobryum*, the cells are of two different kinds, one large and empty, the other very small and containing chlorophyll, thus giving the leaf a light yellow-green color. "In *Sphagnum* the green cells of the leaf-blade are all connected together and form a network with elegant, bent walls, whose meshes are occupied each by an empty cell. The green cells serve for the assimilation of carbon, the empty ones (like those of the stem) for conducting water." Generally the marginal cells of the leaf, and those of the central band, when that is

present, are much smaller than the others, and arranged in several layers, thus constituting the elements of an epiderm and midrib. The midrib, or costa, sometimes extends beyond the point of the leaf, terminating in an awn or bristle. In some species (particularly among the Hypnums) there are two costæ, but in such cases they are usually imperfectly developed and do not extend to the end of the leaf. In some genera, notably *Thelia* and *Thuidium*, the leaves are studded with papillæ, sometimes simple, sometimes two-lobed at their apex.

The branching of the stems of mosses appears to be "neither dichotomous nor axillary; the number of lateral shoots is always much smaller than that of the leaves. When the primary shoot produces a so-called 'flower' at its apex, a lateral shoot situated beneath it not unfrequently displays a more vigorous growth of a monopodial character, and is then termed an innovation." Prolification, the prolongation of the stem by the continued growth of the bud within and above the male "flower," is a very common occurrence in *Polytrichum*, and sometimes seen also in *Atrichum*, etc.

The propagation of mosses takes place in two ways; sexually, from spores; and asexually, that is by a vegetative propagation, which is of several kinds: 1st, by innovation, a process of renewal at the apex, while the older parts die off behind; 2d, by means of gemmæ, stolons, or detached buds, (in *Tetraphis pellucida* the leafy axis frequently bears a terminal cup-shaped receptacle, containing many lentiform, stalked gemmæ; these separate spontaneously, and give rise to a kind of protonema, and upon this buds arise, from which leafy axes are developed). 3d, by the non-sexual production of a thallus or protonema. This is sometimes produced from detached leaves, and can also be produced from the rhizoids if placed in the light and kept moist. I have a tuft of *Funaria* which was laid upside down under a bell-glass for about two weeks, and occasionally dampened. The protonema developed from the rhizoids has already produced a large number of leafy shoots. A tuft of *Mnium* similarly treated will produce a like result. This shows that although the rhizoids differ from the protonema in their tendency to grow downwards, and in not containing chlorophyll, yet there is no sharp distinction between the two; each possessing the power of producing leaf stems which differ in no respect

from one another. "The facility of these various modes of vegetative multiplication gives rise to the tufted or cæspitose habit of many species."

The most important, however, is the sexual reproduction, or that from spores. The life-history of a typical moss originating from a spore may be briefly told as follows: The spores, which are produced in vast numbers in the sporangia or capsules, are scattered by various agencies; those which fall in favorable situations germinate and give rise to new individuals. "In the germination of the spore, the exospore (the outer coating of the spore) is ruptured by the swelling of the endospore (the inner spore-coat) which protrudes as a tubular filament. This filament elongates by the continued growth of an apical cell; partitions form at short intervals, and the threads branch freely, giving rise to a green conferva-like mass called the protoneme or protonema. In the Sphagnaceæ, however, the protoneme is a flattened mass, somewhat like the plant-body of the lower liverworts." After a period of vegetation, small buds arise upon the protonema which develop into leafy stems.

The protonema usually disappears entirely after the formation of the leaf buds, but in some cases (especially in the *Phascaceæ*) it remains vigorous even after the formation of the spore-case. The leafy stems which arise from the protonema produce numerous root-hairs or rhizoides at the lower part, while towards or at the summit a kind of inflorescence is developed which contains the sexual organs. (In some genera the organs of fructification are developed at the apex of the stem, in others at some distance below. This forms the basis of a separation of the mosses into two divisions; the *Acrocarpi*, in which the fructification is terminal, and the *Pleurocarpi*, in which it is lateral). This inflorescence consists usually of crowded and somewhat modified leaves, or leaf-like bodies, constituting the *perichætc* or perianth, within which the reproductive organs are formed. It is often rosette-like in shape, and, particularly in the male flower often reddish in color, bearing a strong resemblance to the bracts or even the calyx of some flowering plants.

The male organs are termed antherids or antheridia; the female organs archegones or archegonia. Sometimes they are both found in the same inflorescense, forming a "hermaphrodite flower." Sometimes they occur in different flowers on the same

plant, or on different plants, when the inflorescence is called respectively monœcious or diœcious. They are often accompanied by variously-shaped filaments, generally hair-like, called paraphyses.

"The mature antherids are generally club-shaped, stalked bodies, (spherical in Sphagnaceæ) the outer layer of their cells forming an enclosing wall, while each of the small and numerous crowded cells in the interior develops an antherozoid. These bodies are spirally-coiled threads of protoplasm, thicker at the posterior end, and tapering to a fine point at the anterior end, where they are furnished with two long, fine cilia, whose vibrations set them in constant motion. When the antheridium is mature its wall ruptures when wet, and the sperm-cells escape in a mass of mucilage; the walls of the sperm-cells break, and the antherozoids (or spermatozoids) are set free."

The archegones, or female sexual organs, are shaped like a flask with an oval body and a very long neck. In the lower or enlarged portion (the venter) there is one cell much larger than the rest, the central cell. This becomes divided by a horizontal septum into the two parts; in the lower and larger part the germ-cell, or oosphere, is developed. The neck of the archegonium is occupied by a single row of cells, the canal-cells. Before impregnation these canal-cells are transformed into mucilage, forcing apart the four apical or lid-cells of which the so-called stigma of the archegone is composed, and forming an open canal through which the artherozoids may reach the oosphere.

The structure of these various organs may easily be examined by again resorting to *Funaria hygrometrica*. This moss is especially suitable for purposes of demonstration because of its very common occurrence, and because at almost any time of the year it may be found in all stages of development. Select a stem bearing a tuft of modified leaves at its apex, which may readily be done with the aid of a hand magnifier, or even with the naked eye, and either make longitudinal sections with a sharp razor, or with a pair of fine pointed forceps pluck off a few of the upper leaves and tease them apart with needles under the dissecting microscope. Sections will of course show better the relative arrangement of the parts, while the teased preparations are best for examining the individual organs. On examining the preparations in a drop of water under an inch or

half-inch objective, the flask-shaped archegones will be seen to good advantage, although a higher power will be necessary to show the finer details of structure. The male flowers will be found close by, as this moss is monœcious; they are more rosette-like in form. By treating one of these in the same way, we shall find the antherids with very little trouble. They will be seen to be club-shaped bodies supported on short pedicels, and among them will be found numbers of the very peculiar paraphyses of this genus resembling jointed rods or hairs, each with a ball on its upper end. If the antherids are at the proper stage of development, we shall also see the antherozoids, though a much higher power, such as $\frac{1}{8}$ or $\frac{1}{10}$ immersion, will be needed to show their structure clearly. Their motion will attract the eye at once.

The presence of water is necessary to the act of fertilization. When the moss is wet with dew or rain the antherozoids move freely through the water by means of their cilia, and some of them find their way down the open channels of the archegonia and unite with the germ-cells or oospheres. "As a result of this union, the germ-cell surrounds itself with a wall of cellulose, and soon undergoes division in various directions, giving rise to a many-celled mass, the young sporogonium. Usually the young sporogone rapidly elongates, and soon ruptures the archegone transversely, carrying the upper portion up with it in its growth (it becomes the calyptra of the new capsule), while the lower portion is termed the vagine or sheath. The lower end of the young sporogonium penetrates some distance into the tissues of the stem, the central portion becomes the slender pedicel or seta, while the upper end develops into a spore-case called the capsule or theca. "The spore-case differs much in its structure in the different orders, but in all certain internal cells become spore mother-cells, which divide into four daughter-cells, the spores.

In the great majority of mosses, including the Bryaceæ and Sphagnaceæ, the capsule is furnished with a lid, or operculum, which falls off at maturity, permitting the spores to escape. In the Andræaceæ the capsule opens by four longitudinal slits. In the small order Phascaceæ the spores are set free only by its irregular rupture or decay.

The falling off of the operculum discloses the peristome, a

row of tooth-like structures, or a combination of these with cilia, which surround the mouth of the capsule. This, in many species, is an object of great beauty under the microscope, and in the variety of its structure forms one of the most useful characteristics in the systematic study of the mosses.

THE MICROSCOPIC STRUCTURE OF CERTAIN FEATHERS.

DR P. L. HATCH,

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II.

WE see here the manner in which the continuous web of a feather is formed which, within the range of a certain measure of force, will enable the vane to resist strain; the anterior series of barbules with its armature crossing and overlapping the posterior down through which the hooklets are thrust, the cilia remaining on top to antagonize them and maintain their adjustment. The diagonal direction which the two series of barbules sustain to each other allows the hooks of a single one of the upper series to successively grasp a corresponding number of the barbicels of the lower, thus forming a delicate network of meshes, the partitions of which are hard, polished, and rounded above, allowing the air to pass freely through the entire wing in its upward movement, but which in its downward stroke, by the pressure of the air upon the convex surface of the curved inferior expansion of the shaft of the barb, closes the meshes of each feather of the entire wing completely. When this arrangement is fully understood there is no longer any mystery about the question of *how* a bird flies. The elastic, membraneous, lower portion of each barb in these wing feathers, as well as in those of the tail of all aerial birds, is so adapted to the webbed, inter-barb space between the parallel shaftlets of the barbs constituting the same, that no air can possibly pass through upward while the bird is on the wing, while by the same arrangement the upward motion of the wing meets with little resistance. The larger portion of the feathers investing a bird are called, in taxonomic parlance, contour feathers.

Possessing all of the essential elements before stated, some of them are greatly modified in the details of their structure, a few

of which we will examine somewhat minutely. Take one, for example, from the breast of the swan and while each element of the type is recognized at once, we find every one of them differing from it so much as to suggest a new form of structure, yet it is merely a modification of each to meet the demand for contour and incidentally other purposes.

Notably the calamus is shorter, softer, more elastic; the barbs of the superior umbilical section are fragile, knobbed near the base, beyond which the knobs are developed into lateral spines to the extremities, and without changing the arrangement of the barbicels in rows along the superior angle, the rounded, fluffy form is obtained by the flection of certain ones in the flattened portion, so as to point those spined filaments outwardly in every direction.

This arrangement of the plumage extends some distance along the shaft from the umbilicus when the barbs begin to be more compacted, flattened at the base into curved, lamillated, linear expansions, followed a short distance by modified barbicels the cilia and hooklets of which commence to form a frail web that extends with each successive barb until the series expands into a leaf-like form, beyond which the barbs are continued as double-spined, floating threads to great length, terminating with spines.

Thus by changing the arrangement and form of the barbules and barbicels never so little, if abruptly, patterns of beautiful outline in great variety are obtained, to which if are added tints of colors in the barb and barbule shafts, the most wonderful revelations follow. The extension of the shafts of these divisions of a feather into long flexible filaments, invisibly spined perhaps, soften the plumage of a bird, or of a given tract of it, into contour and lines of indescribable fascination. On the other hand abbreviation of these portions, even the omission of one vane and wide separation of those on the opposite with high coloring, gives us instances of the most resplendant plumage, as found in the case of the Lyre Bird and many others. In the crest of the Kingfisher (*C. alcyon*) so common to our lakeshores and clear, limpid streams, we find long, narrow feathers with the arrangement of the barbs and barbules such as to make them almost indistinguishable from the antennæ of some of the larger moths, when under a magnification of about 160 diameters

Fig. 7, gives an outline of one such. The scattering barbules

are curved gracefully toward the shaft till their bifurcated tips impinge upon the external curvature of each preceeding barbule. A feather from the crown of a Great-crested Flycatcher (*M. crinitus*) presents still narrower barbs with rib-like superior, and expanded, thickened border of shaft inferiorly, with an ovate, inter portion filled with pith-cells. The lower barbules are very thin, wide, granulated and closely set at the base, with one to two dentate spines along the superior border, changing gradually to a round shaft with four-spined knobs, dividing it into joints, a single inner spine of which becoming more prominent successively until the apex is reached, where it is so marked as to be a specific character. Ascending the barb serially, this form of barbule is replaced by those with the flattened portion of the anterior series followed by tapering shafts without knobs, but with a few hooklets beyond which are occasional spines along the inferior border to the extremity, which is also divided but into spines of equal length. The posterior series of barbules, like the former at the base, pass gradually into rounded, unmarked shafts, except that they are also apically bifurcated.

There may be seen another example of these modifications of structure, in the familiar plumage of the peacock's tail. It may be trite to say of it, "How resplendant! How magnificent, how transcendantly beautiful!" yet, however frequently seen we never cease to think of it in these or kindred expressions, even if we do not utter them with our lips; but when with only the lower powers of the microscope we enter upon the analysis of one of these gorgeous feathers, a painful revulsion from our enchantment makes us ready to consign that unsympathetic, unsentimental instrument to the shades of irreclaimable oblivion.

Pluck off from the shaft an isolated barb, long and drooping, or a shorter one from the heart of the "eye-spot" at the extremity, and with only our unaided vision we behold a *myriapod* with its thousand legs protruding stiffly from each border apparently ready to crawl away from under our eyes.

If the barb has been taken from the upper part of the plume where the iridescence is greatest, a short section under about 120 diameters will show a deep, thin, angulated shaft of pith-cells, thickly studded on either side with club-like opaque segmented barbules terminating in a few digitate, claw-like appendages resembling a magnified spider's foot. Fig. 8 gives a good

representation of one from the anterior series of barbules with its digitation, serration and segmentation. The posterior series differs from the other only in the abrupt absence of the divided extremity of the barbule. The segmentation strikingly resembles that of a tapeworm.

What an instantaneous transition from visions of iridescent glories, to myriapods, spider's feet, and tapeworm! yet this is but one disapointment in studying the modifications in the microscopic structure of feathers, to be offset by many in the other direction.

A remarkable variation is found in the extremities of the shaft and barbs of some feathers on the crest, throat, breast, wings and tail of several species belonging to widely separated genera. An example may be named in the case of the cedar bird, where the tips of the shaft of the secondaries and tertials, as well as of the tail feathers, are expanded into conspicuous appendages, reaching beyond the contour outline of the feather to which they are attached. They are scarlet-red, and are composed of the same horny material as that of which the exterior of the entire feather is formed. In each the outline is widest at the rounded extremity, tapering uniformly backwards until lost in transposition into the shafts of the feather and its barbs. It is without pith, and resembles red sealing wax which has been poured upon the feather in a melted state, involving the ends of several barbs on one side of the shaft but leaving the lower portions still distinct and without the characteristic coloring. In one instance, only the anterior series of barbules are buried in the scarlet mass while the posterior series remain free.

At some stage of the development of this singular appendage it has received an imprint of the barbs and their vanelets of barbules in their reverse arrangement.

But for the latter circumstance, the presumption would be that the apparent impression is not an imprint, but the barb itself, partially or slightly covered by the pseudo-sealing wax. Possibly more extensive observations may show that some of the wing-feathers may not reveal such markings, and the tail feathers, which do not ordinarily have those appendices, even on the oldest male birds, may give some clew to their history in development. They have never been seen, so far as I am aware, on the feathers of this species of the first year, and not at their

fullest development in ordinary cases until after the third moult. Several foreign warblers have similiar plates appended to the crest, breast, and throat-feathers in other colors, but I have not yet been able to examine them critically. It is a field that I shall hold in reserve until opportunity offers, unless I find it already pre-empted and occupied.

CYTOLOGY, OR CELLULAR BIOLOGY.

HISTORY OF THE SCIENCE—SECOND PERIOD—CONT'D.

V.—GENERAL CONSTITUTION OF THE CELL AND SOME NEW DEFINITIONS.

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NOT only was the character of protoplasm studied during this period, but the *general constitution* of the cell was also made the subject of special researches. Among others, we find sepecially von Mohl, for a period of twenty years, edited an uninterrupted series of masterly publications, in which he sets forth not only the internal organization of the vegetable world, but also the general structure of the cell, and more particularly its minute organization, which no one before had even suspected to exist. Von Mohl studied particularly the solid membrane and the plastic membrane, the distribution of the protoplasm in the interior of the cell, the nature of the inclusions, the chemical composition of the membrane, the albuminous nature of protoplasm, thus elucidating so many points in the study of the cell, that he may be justly styled the father of Cytology. From this the reader may see that von Mohl justly merited the eulogy of Henstein, who thus speaks of him in an article on protoplasm, published in the *Revue Internationale.* Oct. 15th., 1880: "It was reserved to Hugo von Mohl to elucidate the subject of the elementary structure of the cells of plants in its most ingenious simplicity. Not only did he lay the first true foundations of our actual knowledge upon this subject, but he exposed clearly its most important traits."

In 1844, von Mohl called attention to an essential point, namely, the differentiation of the peripheral layer of protoplasm. He showed that this layer is modified and transformed into a thin lamella, which he calls utricle or primordial membrane.

Schleiden had regarded this membrane as a mucilaginous zone; but von Mohl in answer to Schleiden says: "The question at issue is not one concerning mere words. A peripheral layer, which is differentiated, more dense than the internal protoplasm, and capable of folding itself so as to involve also the cellular contents, presents without doubt, all the characteristics of a true membrane."

In speaking of the vacuoles and the fluid they contain, he calls this fluid "cell-sap," and he states expressly, in accordance with Dujardin (as above cited), that we must not mistake this fluid for the protoplasm. He says: "This (the protoplasm) is repelled by the cell-sap and sometimes reduced into threads which break and contract towards the periphery where the whole protoplasmic mass will form a sac enclosing a large vacuole filled with water, *i. e.*, cell-sap. These vacuoles, therefore, are nothing but inclusions."

According to von Mohl the grains of starch, of aleurone and crystals, etc., are only inclusions contained in the protoplasmic mass, but entirely distinct from it.[1]

We may sum up the statements of von Mohl in the following words: The vegetable cell is a closed utricle surrounded by a solid membrane, containing a protoplasmic body in which is lodged a nucleus. With regard to the protoplasm itself, we must distinguish a peripheral part, which is differentiated into a primordial membrane, and the internal part, which in young cells is homogeneous, but in mature cells is sometimes reduced to mere threads by inclusions, or even it may form a sac close to the cellular membrane.

Von Mohl goes still further. Convinced, as he was, that in Cytology every term must receive a meaning he is careful to determine precisely what must be attributed to the word protoplasm. "In general," he says in 1846, "this word is used to signify that opaline and viscous mass which exists prior to the parts of the cell; and in fact, it is this protoplasm which furnishes the materials out of which are formed the primordial utricle and nucleus." Thus he characterizes living matter. Later however, in 1851, when he treats *ex professo*, of the cellular organization, having

1 Prof Carnoy introduces two terms to represent the inclusions of von Mohl. He reserves the term inclusion for foreign substances introduced into the cell, as water, Diatoms, etc., and he gives the name *inclavata* to those substances formed in the cell by the protoplasm, such as starch, aleurone, etc.

spoken of the primordial utricle and the nucleus, he adds: "The remaining part of the cell is more or less filled by an opaline, viscous, white and granular substance, which I call protoplasm."

Thus, according to von Mohl, in a complete cell, with membrane and nucleus, the name protoplasm is reserved to the hyaline and viscous part, which remains between the two in its primitive state.

Von Mohl, by his interesting researches had realized an immense progress in the science of Cytology; yet one mistake he made, and that is, he confined himself to the study of the higher plants.

Thus while Von Mohl confined himself to the plant cell, other investigators applied themselves to the study of the animal cell, and particularly to the Protozoans, and arrived at conclusions somewhat different from those of Von Mohl. Schwann, who had regarded the membrane as an essential part of both the animal and vegetable cell, now abandons his position, and confesses its absence in the white blood-corpuscles; and, the study of the zoospores of algæ and fungi and of the Myxomycetes, etc., more even than the study of the higher animals and plants, soon convinced most investigators that the views of Von Mohl required great modification.

Leydig, in 1856, was the first to abandon the definition of the cell which till his time had obtained. "The contents of the cell," he says, "are of greater importance than the membrane; for there is the seat of irritability and contractility." About the same time (1861), Brucke doubted whether the nucleus is an essential part of the cell, since among cryptogams many cells are found devoid of a nucleus. Schwann (1854), in the study of the *Amœba porrecta*, had already noticed the absence of a nucleus. Soon many more examples of the absence of a nucleus in cells multiplied to such an extent that Haeckel deemed it necessary to establish a whole group of animals, the Moners or cytodes, characterized by the absence of the nucleus. At this time, therefore, we find many scientists who regard the cell as "a simple globule of protoplasm," which even by some is regarded as a mere speck of albumen[2].

2 The reader may peruse with great profit the first part of the article on Physiology in the Cyclopædia Britannica.

Whilst many studied the protoplasm and the cell membrane, a few also gave their attention to the study of the nucleus, but they met with little success. It had been stated for a long time, that the living nucleus appears within the protoplasm as a clear spot, more or less granular in structure and containing an aqueous fluid. Schleiden (1838) had described and illustrated some nuclei with contracted granules appearing to be arranged in a certain order[3].

Nægeli (1844) and Unger (1846) had observed that the nucleus in many cases is also surrounded by a membrane. In the nucleus, microscopists had reached the limit of investigation, for want of perfection in their instruments. During the subsequent twenty years no advance was made in the study of the nucleus. To-day one thing was affirmed by one to be denied the next day by another, and as to the nature of the nucleolus, the wildest statements were made. Finally, the study of the nucleolus was totally abandoned for want of suitable instruments.

In conclusion let us call attention to a radical mistake made almost by all investigators in their study of the nucleus. As a rule the nuclei of the eggs were chosen as the subject of investigrtion, but these nuclei are the worst kind that could have been selected. True, they are generally of large size, but they are far from being typical and normal.

THE MEASUREMENT OF APERTURE AND WORKING DISTANCE.

GEORGE E. BLACKHAM, M. D., F. R. M. S

THE angular aperture of an objective is properly the angular value of the difference in the path of the extreme rays of the widest pencil of rays which can be utilized by it for the production of a well defined image. Imperfectly corrected lenses may transmit rays more oblique than can be brought to a common focus with the less oblique central rays, but as these rays do not contribute to the formation of a well defined image, serving on the contrary, only to confuse and distort it, they have no claim to be included in the available aperture of the lens.

It would seem hardly necessary to argue that in order to as-

3 Evidently he had mistaken the convolutions, or protuberances of the nucleolus.

certain the aperture of a microscope objective, the measurement should be made with the lens in actual use, as it was intended to be used, and not as a spy glass or telescope, yet it is the telescopic method that is most frequently described and recommended in books on the microscope.

The method that I demonstrated at the meeting of the American Society of Microscopists at Buffalo, and shall here describe, is that used by the late Robert B. Tolles and of which he is, as far as I know, the originator. It is essentially as follows:

The objective to be measured is attached to the microscope with an eye-piece exactly as for ordinary work, and is focussed on some suitable object in the centre of the field, the correction collar being used if necessary to get ihe best image the objective is capable of giving. The object should be a transparent one, and one the resolution of which is a fair test of the powers of the lens. After these arrangements have been completed, the body of the microscope is turned to a horizontal position, the mirror swung out of the way, and the object illuminated from below the stage by a narrow radiant, such as the flame of a toy candle. The source of illumination is then moved to the right and the left in succession till either the centre of the field becomes darkened or the image is spoiled. The angular value of the distance through which the source of illumination can be moved before this takes place is the available angular aperture of the lens; that is, the useful aperture for definition. In some lenses the image is spolied long before the centre of the field is darkened, so that the aperture, for mere transmission of light, is much greater than that for definition. Such lenses are imperfectly corrected for the marginal rays, and their performance can be improved by cutting off these aberrant marginal rays by means of stops or diaphragms, and so reducing their augular aperture (for transmission).

The plan of measurement here described, if used without any device below the stage, can measure only apertures below 1.00 Numerical Aperture; that is to say, angular apertures of 180° air, of 97° 31′ water, or of 82° 17′ in glass or homogeneous immersion fluid, and must always give the results in terms of the equivalent air angle. Hence when we have occasion to measure the aperture of a lens exceeding, or indeed closely approaching 1.00 N. A., it becomes necessary to use, below the slide, some

device like the little hemispherical lens called by Mr Tolles his "Traverse Lens," which being attached to the under side of the slip by an immersion contact, allows the rays to pass into the slide without refraction, and consequently gives the angle in terms of the glass or the homogeneous immersion angle. When this device is used with a dry objective or a water immersion, it becomes necessary to translate the aperture indicated by the movement of the source of illumination, which is the angle of homogeneous immersion, into the corresponding angle for air or water as the case may be. This is easily done by a very simple calculation founded on the law of sines and the rule of three, and still more easily by reference to the table of aperture published by the Royal Microscopical Society as part of the cover of each number of their Journal, and republished in this country in various places, of which the catalogue of the Bausch and Lomb Optical Company, of Rochester, N. Y., and the Proceedings of the American Society of Microscopists for 1883, are perhaps the most readily available.

The plan of measurement here outlined is sufficiently accurate for such approximate determinations as are within the technical skill of the non-expert for whose benefit the working sessions[1] demonstrations are especially intended.

If the microscope stand is provided, as it should be, with a radial arm for the mirror, and a means of reading the obliquity to which it is swung, it is easy to substitute a toy candle for the mirror and to proceed as directed in the foregoing. If the stand is not provided with a radial arm, the process becomes a little more complicated, but there are numerous methods for determining the angular value of the distance through which the source of the illumination is moved, which will readily suggest themselves to any one with even a slight acquaintance with mathematics and trigonometry.

If greater accuracy is desired, it can be secured by the use of an opaque slide with a transparent line across it in which the objects are mounted, and this line can be so placed on the stage as to bisect the field of view very accurately in a vertical direction, and the exact moment at which the centre of the field is darkened can thus be determined with greater precision. Such

1. This paper was read before the Buffalo meeting of the American Society of Microscopists, at the working session.

a slide can readily be made by cutting a 3x1 inch slip from a photo plate, exposing it to the full sunlight, developing and fixing it, and then drawing a sharp knife across it on the film side. In the transparent line thus made, Diatoms or any other objects may be mounted in balsam, and covered in the usual way. Still greater accuracy could be secured by the further use of a very brilliant source of illumination behind the screen with a very narrow vertical slit, or by the use of the tiny incandescent lamps which are now available.

WORKING DISTANCE.

The working distance of an objective is the amount of clear space between the face of the objective and the upper surface of the cover glass, when the object is in focus. It is a variable quantity, being affected by the special construction of the lens, the length of the tube, the power and construction of the eyepiece, and the thickness of the cover glass.

The method of measurement is so simple and obvious that it hardly needs explanation, but is as follows.

I have on the body of my microscope a scale, and on the arm a vernier, by means of which I can determine the position of the body to the one one-thousandth of an inch. I focus the object carefully and take a reading; then with the coarse adjustment I rack cautiously down till the front of my objective is just in contact with the upper surface of the cover glass, and take another reading, the difference between the two readings being the working distance of the objective under those conditions. Stands in which the fine adjustment moves the whole tube, a plan introduced by the late Joseph Zentmayer in his Centennial model, are especially convenient for this work, as in them the fine adjustment can be used to complete the contact between the objective and the cover glass, and thus decrease the chances of damage to either, while in stands with the fine adjustment moving the nose-piece only, the adjustment can not be used for this purpose as the movement of the objective effected by it is independent of the body, and consequently would not be included in the movements of the body and could not be read off on the scale.

AMERICAN MICROSCOPES AGAIN.

PROFESSOR WM. H. SEAMAN.

In THE MICROSCOPE for March we find on page 96 a remark that the work done in America with American stands and objectives does not compare with the work done with the instruments of Zeiss, Leitz, and Hartnack. Also that American makes have many faults. It would have been more important if the faults had been specified.

By a symposium published in "Science," in 1889, p. 120, it will be found that Ann Arbor and Cornell, two of the largest universities in the country, use largely American microscopes. The quality of the work done at these institutions is admitted, I think, to compare favorably with that done anywhere else, in evidence of which I may refer to the papers of Cornell University in the volume of the Proceedings of the American Society of Microscopists for 1890.

By the same article in "Science" above cited, it will be found that the men who, so far as I know, stand at the head of the list of American microscopists in the length of time they have used, and the amount of work they have done with the instrument, to wit, Dr J. G. Hunt of Philadelphia, Prof H. L. Smith of Geneva, N. Y., and the Rev Francis Wolle of Bethlehem, Pa., express their opinions unequivocally in favor of American instruments. The recent publication of the book on the Diatomaceæ of North America by the latter author completes a series of works that have required an amount of labor with the microscope rarely equalled, the number of figures published being over 5,400; probably over 10,000 individual objects were drawn by the aid of the microscope to produce these plates.

An analysis of the matter will show, in my opinion, something like the following state of affairs. The foreign professor who is unacquainted with American work, and who has frequently a tendency to undervalue it, and the American student who looks through a microscope for the first time when he stands within the walls of a German university, acquire prepossessions in favor of the instruments they first learn to use. They naturally send to the makers they are already acquainted with, when additional instruments are wanted. Now the question is, will this course of action build up those manufacturers and mechanics

in this country who try to establish and maintain a reputation for scientific work in America? If no American bought an American microscope who would make one? The men who affect to despise American work are often quite ignorant of what has been done by Americans, and do nothing themselves to improve it. It is clearly the duty of the American scientific investigator to support the American scientific mechanic, and by mutual coöperation, to raise and maintain the character of American scientific instruments to that superiority which America has already established and maintains in other machine construction.

A brilliant example of what has already been accomplished by this method of coöperation, is the establishment of Mr Brashear's at Pittsburgh (not for microscopes), where the man of science who wanted new and original work done, sought for the American mechanic to do it, assisted in his training, and the two produced an establishment to which all the world now pays tribute. Of a similar character is the workshop of the Clarks, at Cambridge, Mass., for telescopes, a line closely allied to microscopes. Those who prefer the German pattern of microscopes, will have no difficulty now in getting it of American make.

It may be said by some that these remarks are the result of a species of ill-advised and unjustifiable patriotism. A pretty large acquaintance with the scientific literature of Europe enables me to say, that a disposition to maintain or even exaggerate the scientific achievements of one's own country, is by no means unknown among the savants of Europe, and I think a little tendency in that direction is at present a desirable element in the character of our native scientists and students. The leading German maker of microscopes when seeking to improve his art, has received large financial aid from his government. The American who first discovered and worked out to completion the very improvement on which the fame of the German rests, living under the shadow of our most renowned University, received scanty support and little credit.[1] The fluor spar lens, on which the alleged superiority of the German objective is now said to depend,[2] it is certain from the evidence before us was discovered and practically applied by an American maker before

1. Proc. Am. Soc. Microscopists, 1884. p. 36-38, "Robert B. Tolles and the angle of aperture question." Mayall's Cantor Lecture, Jour. Soc. Arts, p. 1119, vol. XXXIV.
2. Pro. Am. Soc. Microscopists, 1890, p. 248.

it was seriously thought of in Europe.[3] The swinging tail piece, first definitely adopted by an American maker, is rapidly becoming an essential feature of every good stand, and the Zentmayer slip stage, for those who desire a slip carrier, is universally acknowledged to be the best made. Let any competent student take an American type of student stand in a laboratory supplied with the clumsy and inconvenient German stands usually furnished to students, and he will immediately become envied by his associates because he possesses an instrument better adapted for all kinds of work than those the others have.

In conclusion there is one point on which we may make an improvement.

In 1884 the American Society of Microscopists appointed a committee to see if some arrangement could not be effected with the London Society to improve the character of the taps for the universal screw sent out by the London Society. In 1887 that committee asked to be discharged, on the ground that the correspondence which had taken place showed that it was impracticable to make any arrangement with the London society. Now it is a pertinent question if we are obliged to be content with the present unsatisfactory state of this matter. The number of microscopes now made in this country is very large and is increasing. Unless steps are taken to secure taps of standard guage and size, no uniformity will ever be attained.

One of the principal difficulties in the way is understood to be that the shape of the thread unfortunately chosen is not adapted for grinding true. Now as the effort for coöperation has failed, it might be better to start independently, and make our own standard taps, since we have both the skill and the apparatus to do it better than it is done in Europe, and if we agreed among ourselves, there is little doubt but that our standards would be accepted.

The indictment brought against those furnished by the London Society is that they were not round, that they were unlike in size and pitch. It may be that if a cylindric head with bayonet catch had been adopted in place of a screw, it would have been easier to make an accurate fitting, as it is a difficult matter to turn or cut a screw thread that shall collimate precisely. Be

3. Zeitschrift fur Instrumenten Kunde, 1890. pp. 1–6, trans. in Queen's Bulletin, Feb. 1891.

this as it may, it seems to me that a revival of this subject with a view of doing the best we can with our present improved methods, and increased knowledge, would result in having a great deal more uniform objective fittings than we now have.

REFERENCE TABLES FOR MICROSCOPICAL WORK.

III.

CEMENTS AND VARNISHES.

COMPILED BY PROFESSOR A. B. AUBERT.

ALPHALT VARNISH: asphalt, 450 grms.; linseed oil, 225 grms.; turpentine, 1,000 c. c.; or dissolve asphalt in benzol and to the solution add gold size. In the first method, dissolve by the aid of heat; dilute when ncessary, with turpentine. Not very reliable as a cement.

BELL'S CEMENT: probably a solution of shellac, but the exact composition is not known. This in the opinion of many is an excellent cement.

GOLD SIZE: linseed oil, 25 ounces; red lead, 1 ounce; powdered white lead and yellow ochre, of each a sufficient quantity. Boil the oil and red lead together carefully for 3 hours; pour off the clear liquid, and boil with a mixture of equal parts of the white lead and yellow ochre added in small successive portions. Let it stand, and pour off the clear liquid for use.

GRAM-RUTZON'S CEMENT: hard Canada balsam, 50 grms.; shellac, 50 grms.; absolute alcohol, 50 grms.; anhydrous ether, 100 grms. The ingredients are mixed, and when the gums are dissolved, filter if necessary, and evaporate, away from the flame, over a water bath until of syrupy thickness.

GUTTA-PERCHA CEMENT (Harting): gutta-percha cut in pieces, 1 part; turpentine, 15 parts; shellac, 1 part. Heat the gutta-percha and turpentine together, filter, add the shellac pulverized, and heat until a drop hardens on a cold glass plate. Used to attach cells; the slide must be warm when using the cement.

BROWN CEMENT: pure gum rubber, 20 grains; carbon disulphide, a sufficient quantity; shellac, 2 ounces; alcohol, 8 ounces. Dissolve the rubber in the smallest possible amount of the carbon disulphide; add this slowly to alcohol, avoiding clots; add powdered shellac and place the bottle in boiling water until the shellac is dissolved and no more smell of carbon disulphide is given off.

GUIACUM VARNISH: gum guiacum, 2 ounces; shella , 2 ounces; alcohol, 10 ounces, The powdered gum guiacum is lissolved in the alcohol and the powdered shellac added; keep the bottle in hot water until all is dissolved.

SHELLAC VARNISH: 1, shellac, 60 grms.; 2, alcohol, 60 grms.; 3, castor oil, 25 grms.; 4, alcoholic solution of anilin dye, a few drops. 1 and 2 are dissolved and heated until quite thick, then a little of 4 is added, and for every 60 grms. of the mixture add 25 grms. of castor oil, and heat for a short time.

ELECTRICAL CEMENT: 5 parts of rosin; 2 parts of hard balsam; 1 part of yellow beeswax; 1 part of red ochre. The components are melted together. This is not usually employed for mounting purposes, but may be used in cementing glass and metal parts of instruments.

ZINC WHITE CEMENT, GERMAN FORMULA: 1, mastic; 2, dammar; 3, sandarac; 4, Venetian turpentine; 5, turpentine; 6, benzol; 7, zinc white. 1, 2 and 3, powdered, are mixed in a well-corked bottle with 4, 5 and 6; shake well occasionally; after several days filter, and triturate in a mortar with zinc white in quantity sufficient. Dilute if necessary with benzol.

ZINC WHITE, ENGLISH FORMULA: 1, gum dammar; 2, gum mastic; 3, benzol. Dissolve powdered 1, 2 and 3 in a well-corked bottle; when dissolved filter, and mix carefully in a mortar with zinc white.

MARINE GLUE: India rubber shreds, 2 ounces; shellac, 2 ounces. Dissolve the rubber in mineral naphtha, add the powdered shellac, heat until liquefied, and mix well together. This gives solid marine glue, and requires heat in its application. Great care should be observed in having all fire and flame removed while there still remains naphtha in the mixture.

LOVETT'S CEMENT: powdered white lead, 2 parts; powdered red lead, 2 parts; powdered litharge, 3 parts; gold size. The white and red lead and the litharge must be very finely powdered; for use this powder is mixed with gold size to the consistency of cream, and the cells immediately fastened to the slide. They are secure in two weeks. This stands considerable heat and is excellent for fluids containing some alcohol. Make a little only of the mixture with gold size at a time, as it hardens quite rapidly and becomes useless.

KING'S CEMENT AND LACQURES. Satisfactory and highly recommended by some.

BROWN'S RUBBER CEMENT. Very good for finishing slides.

MILLER'S CAOUTCHOUC CEMENT. Sold in England by opticians. It is a most excellent and quickly drying cement.

HOLLIS'S GLUE. Somewhat similar to Bell's cement.

Nearly if not all of the foregoing can be most advantageously bought of the opticians and dealers in microscopical materials.

DR LEIDY is dead. It is not easy to write the words. It is hard to accept the fact. There have been a few men that should never die. Dr Joseph Leidy was one of them. He was the noblest of noble men. The kindest of friends, the gentlest, the wisest of men and the most learned of scientists. Did you ever hear of Dr Leidy's speaking a harsh or an unkind word of any human being? No one ever heard such a word from this best and noblest of good and noble men. Leidy never spoke nor fought against another and perhaps a weaker than himself. He seemed to possess an unconscious knowledge of his own greatness, and to feel a happiness in stepping aside to give room for a smaller man But while the little creatures might sputter and hiss for a while, Leidy passed on serenely, did his splendid work and was ever ready to lend a hand to those who had tried to crowd him to the wall. A lion can always afford to smile at the pismires in his way, as Leidy did. He can afford to step over them, as Leidy did.

When a successful attempt was made to crowd him out of paleontology in which he had become renowned, and when his western correspondents were actually bought away from him, he made no remonstrance. "I thought the world was wide," he said, "and that there was plenty of room for us all. I could find some other subject to study. I never force myself into a field that another man is cultivating. That is not kind." Is there another scientist in the land that could truthfully say a thing like that? If an investigator is becoming a successful student

in any department, is not the tendency great to take from him the credit and to claim it; is not the temptation to smash him and to attempt to rise on his ruins hard for some to resist? My observation has so taught me. But Dr Leidy never condescended to such ignoble meanness. When such treatment was hurled at him he only stepped aside, and began to study something else and to adorn it with his master touch, and with his master mind to expose all of the exquisite beauty that he found in it. He seldom answered back, unless the attack was more than ordinarily vicious. And then he had an enviable way of giving a quietus with something more pungent than a bare bodkin, a quietus that was final. But he never fought, nor struggled, nor had an ill word to say of even his most pronounced enemy. And all the enemies that he ever had were those that had failed through their own carelessness and were envious of the master. To vent their petty spite against their own nature they could be mean enough to strike Leidy who towered above like the giant that he was, and made a conspicuous figure to be struck at. His scientific gospel was a gospel of work. He had no theories to preach. His only object was to find the facts and to tell of them. Of course he made mistakes. Was there ever a human being that did not? But he made rather fewer than the majority of workers. His mind was so keen, his insight so acute that he seldom went far astray, and even in those few instances the results were rather the fault of the instruments than of the workman.

He made himself a name in almost every department of natural science, but with all his learning he was so unassuming that it was a pleasure to come in contact with him. To the little fellows he could condescend in a way that was not patronizing and humiliating to the inquirer, but was inspiring and delightful. There was no evidence of condescension. For the time being the inquirer was his equal and his intimate companion. To have been with him for even a short time and to have touched his hand are things to be remembered. But he is dead. Dr Leidy is dead. May the peace that passeth all understanding be with him. Nothing can be too good for Joseph Leidy.

THE "Key to the Fresh-water Algæ and the Desmids" so long advertised in THE MICROSCOPE can not be published, as not enough subscribers have been obtained to pay for the

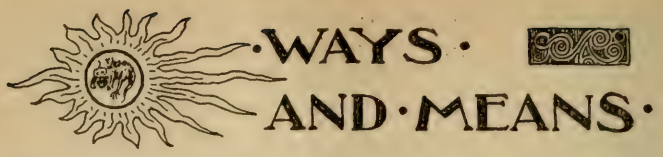
type setting, to say nothing of paper, press work, binding and postage. The few subscriptions received are hereby cancelled.

ACKNOWLEDGEMENT.—To Mr F. E. Ives, Philadelphia, for photo-micrographs of *Triceratium favus*, *Surirella gemma*, magnified 1,000 diameters and beautifully resolved into beads; also of *bacillus tuberculosis*, 1,000 diameters.—To Mr G. C. Taylor, New Orleans, for slides of mummy cloth, 950 years B. C.—To Dr Wm. N. Beggs, St. Louis, for a section of the human retina treated with osmic acid, a mount of great histological value and interest, the various elements being exquisitely displayed; also for blood of alligator, stained with hæmatoxylon, and blood of frog by the osmic acid method. For his glycerine mounts Dr Beggs uses Apathy's cement described in this number, following it with two coats of shellac, and finishing with a layer of asphalt. The result seems to be all that the most exacting could desire. Dr Beggs' preparations can be unreservedly and conscientiously commended in every particular.

NEWS · FROM · THE · WORKERS ·

Dr Laveran gives a very clear account of his methods of examination of the blood in cases of malaria. He points out that such examination is exceedingly necessary in hot countries, where typhoid fever or sunstroke may be mistaken for malaria, or *vice versa*. An examination of the blood always puts the matter beyond doubt. He recommends that the examination should be made just at the beginning of a febrile attack, and before quinine has been administered, as during the period of apyrexia the organisms are seldom found in the peripheral circulation, but appear to be collected in the internal organs, and especially in the spleen. For the examination of the fresh blood, the skin should be cleansed with soap and water, rinsed with alcohol and carefully dried; then, everything being ready, the

finger is pricked with a pin that has been heated to redness, and allowed to cool, the little round globule of blood that appears is touched with a clean slide; a cover glass is lowered down on to the blood, which is pressed out until the film assumes a transparent yellow color; the film is then not too thick, and should be examined at once. The clot that is formed at the margin prevents the drying of the film; but, in order to keep the film thin, it is better to wipe away the blood that is pressed from under the cover glass, and then to surround with parrafin. Daylight and no sub-stage condenser should be used for examinations, or the organisms are rendered too transparent The movements of the flagella and the amœboid movements can all be made out. If the organisms are pigmented they are readily enough seen, but a most careful search may have to be made for those non-pigmented organisms that sometimes adhere to the red blood corpuscles. If the specimen is to be preserved for further examination the film should be prepared by compressing between two cover glasses, which are carefully separated, allowed to dry, and passed two or three times through a clear flame; each film is mounted unstained and dry, with a parrafin rim to keep out the air, and to retain the cover glasses in position. When it is wished to stain the organisms in order to bring them into special prominence, the films, after being heated on the cover glass, are put into a mixture of alcohol and ether, they are then allowed to dry, after which they are stained with a concentrated aqueous solution of methylene blue for thirty seconds; they are then rinsed in water and mounted dry, the cover glass being surrounded with parrafin. The leucocytes are colored deep blue, the free spherical organisms and those adhering to the red blood corpuscles pale blue, whilst other forms are scarcely tinged. A contrast stain may be obtained by using eosin. With these stained preparations artificial light may of course be used. In all cases where possible, both methods of preparation should be resorted to, as each has its advantages.—*Brit. Med. Jour.*



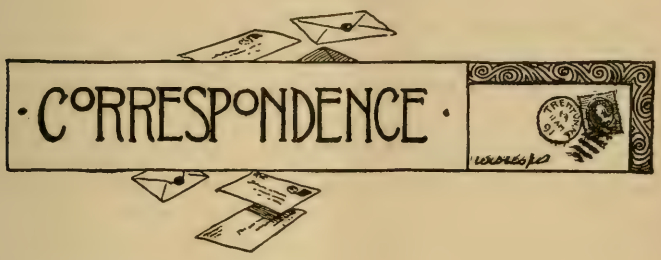
A MINIATURE TANK FOR MICROSCOPICAL PURPOSES.

DR THOMAS S. STEVENS.

Any collector from ponds and ditches, who has searched over the contents of a round bottle with a lens, knows how difficult it is to see and capture the interesting objects it may contain, on account of the distortion produced by the convex sides of the bottle. At a trifling cost a small flat aquarium, or large zoophyte trough, may be made that will obviate this difficulty.

Take two pieces of thin plate glass about six inches square, and from a dealer in rubber goods obtain a strip of pure rubber packing about $\frac{3}{4}$ inch square, and so long that when bent into a horse shoe or U shape, the ends will just come to the top edge of the glass sides, while the curve shall not quite reach the bottom. If the rubber is flush with the lower edge, or a trifle below, the tank will not stand firm when finished. This rubber strip, bent into proper form, is to be cemented between the two glass sides. This may be easiest done by marking on a soft pine board a square exactly the size of the glass, and on this square bending the rubber strip into a U shape; keep it in position by placing pins or tacks, not through but at the sides of this packing, at various points, so as to hold it in shape. Smear the upper side of the packing thoroughly with cement, lay on one of the glass sides, being careful to have it in position, press it firmly on the cement and place a weight above it to hold it down, and leave it over night for the cement to harden. Smear the other side of the rubber strip with cement and place the other glass upon it, being careful to have the edges of both sides parallel. Weight it down, leave to harden as before, and the tank is done. The cement that I have used is Van Stain's Stratena. No doubt there are others that would answer the purpose as well. Marine glue would probably be better. The rubber packing comes in different sizes, from $\frac{1}{4}$ to $1\frac{1}{4}$ inch in thickness. The aquarium may therefore be varied both in size and transverse depth to suit the needs and taste of the maker.

A NEW CEMENT FOR GLYCERINE MOUNTS is described[3] by Dr S. Apathy as being composed of equal parts of hard parraffin (melting point 140° F.) and Canada balsam. They are melted together in a porcelain evaporating dish, and then kept heated over a moderate flame until the mass becomes of a golden color, and emits no more turpentine vapors. When cold the mixture is hard, but it can be readily warmed for use. The author says that it is a perfectly safe cement to be used with glycerine.



EDITOR THE MICROSCOPE:—

In your March and April numbers you publish letters from E. H. Griffith, J. M. Stedman and J. S. Kingsley, claiming to criticise some of my teaching in regard to the microscope stand. I did not before know that I am such an abandoned wretch, nor, as these gentlemen seem to intimate, that I am fit only to be carried out and dumped on the scrap-heap. I feel real sorry for myself. I would however suggest to Mr Griffith that the next time he seeks to criticise he shall not wrench a single phrase from its setting, put a wrong construction upon it, and then try to demolish things in general. Such sham criticism is unmanly. The sentence which he has garbled for his own advantage is as follows: "On no account would I give an intelligent beginner a stand with a short body tube, without coarse adjustment, fine adjustment, movable stage, or substage, a stand with only a little concave mirror, one eye-piece and a cheap objective.[1]"

Mr Griffith also scolds because I recommend a multiplicity and complexity of parts. Again he quotes a single sentence without the context that entirely changes its meaning. A just critic would have quoted the following: "Buy a microscope that

3. Zeit. f. Wis. Mikr.

1. "The Microscope," Dec. 1890, p. 369.

seems far beyond your ability to manage. Buy one with what seems to be a multiplicity and complexity of movable parts, and brass and glass. Buy an instrument to which you may advance, not one beyond which you shall advance at the first step. As your microscopical education proceeds, you will begin to appreciate your microscope, and will no longer think it 'Too good for only me,' or 'Too complicated for only a novice like me,' . . . and will begin to suspect that you have made no mistake in selecting an instrument to be 'lived up to.'"[2] By applying Mr Griffith's method of criticism to his own letter, he may be made to say some astonishing things. By using Mr Griffith's plan the reader might perhaps be able to prove from Mr Griffith's letter, that Shakespeare wrote the Bible.

Leaving out of the question the convenience and comfort in the employment of a short, vertical tube, will Mr Stedman kindly tell us what objectives he uses? Does he put on his short tube objectives corrected for a body of the standard length? If he does, will he please tell us what happens? If he uses objectives corrected for the short body and extends the draw tube, as I take for granted that he does at times, will he again kindly tell us what happens? I have observed that a good objective intended for use on a body of the standard length will not act well when used on a short tube, and that objectives corrected for the short body will act as badly when used on a long tube. But perhaps I have been misinformed and deluded. Will Mr Stedman generously teach us that take an interest in the subject, what is the correct thing to do and to believe in this connection? Personally I shall be greatly obliged to him, and I am sure that others that sometimes use the microscope for their pleasure and their instruction, will join me in thanking him for the proper teaching.

Mr Kingsley says that he "has never seen any work done with an American stand and objectives which can compare with the work done in America with the instruments of Zeiss, Leitz and Hartnack." Does he mean work done in the University of Nebraska? If not, I wonder where he was sleeping when I waked him up? He seems to have been where Moses was when the light went out. Yours truly,

AN AMATEUR.

2. Ib., p. 370.

EDITOR THE MICROSCOPE:—

The argument that Harvard, Princeton and other institutions use foreign microscopes and consequently such instruments must be good, is very misleading. The real reason is this: Institutions of learning may import instruments duty free. They thus obtain microscopes more cheaply. The law intended to aid institutions in procuring instruments not easily to be obtained here, but certainly did not intend to cover the wholesale importation to colleges and their professors, who anxiously solicit the patronage of Americans and in return slyly stab American manufacturers in the back. There is no question as to the efficiency of American microscopes, long and short, vertebrate and invertebrate, and prices seem reasonable, unless you have a "friend in the faculty" who is anxious to shade American prices. Many who will read this will know that I speak the truth and from experience.

S. G. SHANKS.

ALBANY, N.Y.

EDITOR THE MICROSCOPE:—

Cajeput balsam, which has been discussed in your journal, is a preparation that I had at one time thought of making, having used cajeput oil in mounting, finding it better than the old time oil of cloves. My idea was not just like the formula published in your journal, for I had dammar resin in mind. After reading the different experiences of microscopists, it started me again, and I made a solution of dammar in oil of cajeput. Cajeput oil dissolves dammar resin freely, and with a little heat in a very short time, making a clear solution, which afterwards must be filtered through cotton or paper by the aid of heat. The proportions are dammar resin (clear), one ounce; oil of cajeput, six drams.

Mix, and filter through cotton or paper, covering the funnel with a glass plate, and setting over a steam radiator or back of a kitchen stove. I mounted some Diatoms in the cajeput dammar medium, and find it works excellently; by heating the slide it hardens in a short time, and the mount afterwards can be finished in the regular way. Not having the required time to test its drying or hardening qualities, when worked without heat, I will some time later on give my experience.

PEORIA, ILLS. J. E. HUBER, PH. G.

EDITOR THE MICROSCOPE:—

Again I enjoy with you and others the streaming of the protoplasm in the cells of the onion, as I did the continuous microscopic net of protoplasmic lace, so well communicated by you. Many thanks to Profs Gardiner, Coulter, Burrill and you for the interesting discoveries and for the publications. Topsy said "I growed," and the majority of persons say plants grow, but when we see the little granules in the protoplasm moving from place to place, most likely for the completion of the internal structure of the cells, we find a very important part nearer to the commencement, how plants do grow!

When we observe the movement of animalcules and their cilia, we have an explanation of their motions; but the movements of Desmids and Diatoms are not fully explained, neither is the motion of the granules developed from the homogeneous condition of the protoplasm; yet after seeing the movement of the particles by mixing the solutions of acetate of lead and iodide of potassium, before crystalization, or mixing alcohol with water containing visible particles, we find a similar motion. The most plausible theory to my mind is this. The different specific gravity of the liquids, and the streaming from the specifically heavier substance toward the lighter to fill the spaces and to equalize matters, as mother Nature demands.

An onion growing in a glass of water, as we treat hyacinths, has given me the best results. DR CARL H. HORSCH.

DOVER, N. H.

REPORT OF THE COMMISSIONER OF AGRICULTURE, 1888. Washington: The Government Printing Office, 8 vo., pp. 708. This volume contains valuable matter relative to the fungous diseases of certain cultivated plants, with beautiful illustrations of their microscopic characters, while the Report of the Microscopist is devoted chiefly to the investigations of the adulterations of condiments, with colored illustrations of sections, isolated cells and fibres. These portions of the volume are of great interest to microscopists, and merit a wide circulation. Dr Taylor also describes and figures his new pocket polariscope, which he calls an Oleomargariscope. The book may be had if courteously requested from the Secretary of Agriculture at Washington, D. C.

THE MICROSCOPE
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ORIGINAL COMMUNICATIONS

THE IMPORTANCE OF THE MICROSCOPE IN THE DIAGNOSIS AND TREATMENT OF SKIN DISEASES.

A. H. OHMANN-DUMESNIL, A. M., M. D.

PROFESSOR OF DERMATOLOGY, ST. LOUIS COLLEGE OF PHYSICIANS AND SURGEONS.

THE universal tendency of modern times to specialization has made its imprint upon the art of medicine. While general principles are required by every one, the special applications of these principles to certain restricted classes of disease have tended so to enlarge the general scope of the healing art, that one is appalled at the enormous amount of material which has been accumulated in a comparatively short space of time. Dermatology is no exception to this rule and, while it is comparatively young in its development, it compares favorably with the other special departments of medicine in the amount, variety, and value of its literature, as well as in the rapid strides which it has made in so short a space of time. Interest has steadily grown in the study which is to this day a *terra incognita* to the majority of our practitioners of medicine. That this condition is merely temporary, however, is evidenced by the fact that every

medical college, having any pretentions to the name, has established a chair of dermatology, and the younger generation is endeavoring to fit itself to some extent for the successful recognition and treatment of diseases of the skin. This is a difficult task, however, for there can be no reasonable doubt in the mind of any intelligent physician that dermatology particularly calls for acuteness of observation, the careful exercise of good judgement, and a proper discrimination in forming conclusions. The niceties which are developed in the course of a critical examination are such as often lead to important deductions of the greatest therapeutical value. This it is which often necessitates special training in order not to permit these fine points to escape detection. It is these minutiæ which constitute the difficulty in the way of the beginner, and it is a knowledge of these which produce special skill. While it cannot be expected that every one practising medicine should be as intimately acquainted with the details of dermatology as those who devote their entire attention to the subject, a certain amount of information which may be acquired with comparative ease should certainly be learned. This is a matter rather difficult to define, but the diagnosis of typical cases should present no difficulty in the majority of affections, and in some cases when doubt exists we have a means which is so easy of application and so certain in its results, that it becomes a source of astonishment that it is not made available in more instances than we see. There can be no doubt of the importance of making a correct diagnosis. But, although a good training in the observation of subjective symptoms noted in a large number of cases, will fit one to make a correct diagnosis in a large number of diseases. Certain mixed types will occasionally present themselves in which recourse must be had to certain helps to solve a doubt, and among these one of the most valuable to the dermatologist is the microscope.

The applications of the microscope in the practice of medicine, for the purpose of making diagnoses, are to-day so numerous that it would be a work of supererogation to attempt a mere recital of them. That they are various and in the highest degree valuable no one would deny, despite the fact that the information obtained is often of a negative character. Notwithstanding this it so frequently supplies us with important positive information, that it has almost become reproach to a progressive physician

not to possess and use this valuable adjunct as he does his thermometer, stethoscope, hypodermic syringe or any of those other helps to diagnosis and which now-a-days appear to be indispensable to his armamentarium.

For many years the microscope has been looked upon as a scientific gun which it was dangerous to handle unless we were skilled in its use; or, it was regarded as a mysterious agent wherewith the unscrupulous would delude the ignorant. This occasioned the efforts to decry it which have made its detractors ridiculous. On the other hand, it may be described as a boomerang in the hands of the unskillful as an assumption of facts cannot be upheld by invoking a personal equation and everything claimed is susceptible of demonstration. Fortunately that class who have decried the instrument and those who have worshipped it as a fetich are rapidly disappearing. A large number have acquainted themselves with this valuable servant and are deriving that help of which advantage has been taken by the younger generation of physicians.

If then the microscope is of so much value in general medicine not only as a means of diagnosis, but for histological, pathological and bacteriological investigators, its importance only gains strength when it is to be applied to special investigations embracing a particular class of diseases. I do not purpose giving directions as to the manner in which these examinations are to be made in dermatology. It would certainly exceed the limits of any ordinary paper to take up *seriatim* the various troubles and conditions of the skin in which the application of the microscope is of special value. One thing, however, may be done and that is a general division of dermatoses in two classes in respect to microscopic examination for diagnostic purposes. Thus, we have those diseases in which the manipulations may be made *sĉance tenante* occupying but a few minutes for the entire process. On the other hand, we have a class in which some time must elapse in order that the material may be properly prepared for examination, the length of time varying greatly, as it may necessitate the cultivation of micro-organisms or other processes requiring a greater or less amount of time.

While the majority of these manipulations are of a more or less simple character in those cases where a rapid examination can be made, it will be readily understood that a certain amount

of preliminary training and practice must exist. The proper manner of preparing tissues for examination is a thing which requires previous study as well as knack. In the rapid method to which allusion has been made, the technique is simple enough and can be acquired in a comparatively short time. Yet, those who follow this subject closely will find that improved or novel methods are being constantly suggested and introduced, many of which are of doubtful worth. In those cases in which diseases of the skin become the objects of prolonged research the student will find the greatest necessity for preliminary training, not only in all those various and complicated technical details relating to hardening, section cutting, staining and mounting, but he will be suddenly made aware of the value of a thorough knowledge of histology. He will then appreciate the importance of a knowledge of the minute structure of the skin and of its appendages. Further than this, he will also appreciate how useful it is to be acquainted with elementary principles of pathology as shown in the changes observable in tissues. For what will it profit him to make a beautiful preparation of an excised portion of diseased skin and to know that it is not normal, if he is incapable of interpreting the picture which is presented to his view?

I do not wish to be understood as advocating the necessity of every practitioner becoming an expert in microscopy, but I do uphold the absolute value of each one being capable of making such examinations as ordinarily come up in practice, and which are of immediate practical value not only in establishing a correct diagnosis, but in many instances in recognizing some process which has not manifested itself by any clinical symptoms.

In skin disease the value of microscopic examination cannot be overestimated. In mixed diseases, especially in which one masks the other, a very cursory microscopical examination will very often demonstrate the true status of affairs. Where doubt exists we have, as a rule, an easy, rapid and certain method of determining the true condition. I might cite, as an example, a case which I was called upon to treat some time ago. It was one of pustular eczema of the scalp, of an apparently aberrant form. Certain patches were round, covered with thick crusts, the hairs being short. A microscopic examination demonstrated the presence of *tinea tonsurans* at these spots. Again, in a case of pustular eczema of the scalp closely simulating favus, a mic-

roscopic examination demonstrated the absence of the parasite, and treatment directed to the eczema alone was followed by recovery. Other cases of a similar nature might be cited.

It is not always as a means of diagnosis, and consequently of treatment, that the microscope is serviceable; but also as a means of establishing the results of successful treatment, more especially in parasitic diseases. It is true that in this case the evidence is all negative, and that a great many more examinations are necessary to establish the fact of the absence of a parasite than to show its presence. Still, a reasonable number of such examinations being made of material judiciously chosen, is sufficient evidence to enable a physician to dismiss a case without feeling that he has been derelict in his duty.

While no attempt has been made more than the recalling to mind of facts that are well known, it may not be out of place to call attention to a circumstance which is by far too common, and which has, in a great measure, prevented the daily use of the microscope in all branches of medical practice. Students are familiarized in the manipulations of the instrument while at college, but as soon as they are released from the trammels of their *alma mater* they often are prone to neglect these important exercises through a lack of interest, or of an instrument, or of both. A relatively small percentage are fired with enough enthusiasm to continue their work in this direction. After being engaged in active practice a certain length of time they appreciate the need of this valuable adjunct, and then it is only with increased labor that they are enabled to acquire a portion of that which would have been a comparatively simple matter had they steadily pursued it.

As the profession becomes more crowded with scientific as well as practical workers, this necessity will make itself felt more and more. The day is not far distant when the microscope will be in as constant use as other diagnostic aids, and the results obtained will certainly justify the expenditure of time, money and energy which microscopy exacts from the worker in that field.

AT THE MICROSCOPE.

MARY H. WHEELER.

When the busy day is over,
  And the people are at rest,
When the dew is on the clover
  And the birds are in the nest,
Then by microscopic table,
  Lenses good and lamp in place,
Happy they who may be able
  Nature's dainty work to trace;

O'er the Diatom to ponder,
  Moving slowly to and fro,
And to see with silent wonder
  The *Amœba* onward go;
To behold the *Vorticella*
  Cleave in twain and separate,
Or to watch in *Terebella*
  How the fluids circulate;

There to see the fair *Euplotes*
  On swift cilia pass by,
Or enclosed within *Loxodes*
  How refractive bodies lie;
View the *Rattulus lunaris*,
  With his tail-like toe atilt;
And how *Rotifer vulgaris*
  Like a telescope is built;

Learn how Nature's hand arranges
  Every cell to fit its place,
And the protoplasmic changes
  Through the varied tissues trace;
Look within the *Protococcus*
  Where the chlorophyll abides,
Or with nicer care to focus
  Where the bad bacillus hides;

Then the busy brain is sending
  Mental pseudopodia out,
Which around each object bending
  Gather truth from fields of doubt.
Happy hour for those discerning,
  No intruder to molest,
When the evening lamp is burning,
  And the noisy world's at rest.

CYTOLOGY OR CELLULAR BIOLOGY.

HISTORY OF THE SCIENCE (CONT'D).

THIRD PERIOD, 1865–1884.

VI.—ORGANIZATION OF THE PROTOPLASM AND THE NUCLEUS—THEIR CHEMICAL COMPOSITION.

REV A. M. KIRSCH, C. S. C.

IN 1865 it was generally admitted that the fundamental properties of protoplasm in the two kingdoms of Nature are identical, but protoplasm was still considered to be hyaline mass, homogeneous, and of visible structure. Even at the present day many scientists hold this opinion, as may be learned by consulting the writings of Kollmann, Strasburger and many others.

STRUCTURE OF PROTOPLASM.—At first protoplasm was believed to be arranged in concentric zones; namely, an external zone, considered to be more transparent and more homogeneous than the internal mass, which was to be granular, and often enclosing vacuoles and other bodies derived from the protoplasm. Many and various terms were also in use to designate these various parts; thus De Barry (1863) calls the clear, external zone epiplasm; it may be seen in the thecæ of Ascomycetes. Other terms more particularly applied to the Protozoans and to eggs, were Hautschichte, periplasma, ectoplasma, even protoplasm; but for the internal granular portion the following terms were in use: metaplasma, endoplasma, deuto- or deuteroplasma, polioplasma, etc. Recently A. Brass has distinguished as many as five concentric zones, and to each of them he gives a name, to signify some supposed physiological function.

Hanstein from a different standpoint distinguishes three elements in protoplasm, namely: 1st. The fundamental hyaline mass distributed throughout the cell; this he calls hyaloplasma.[1] 2nd. The plastic fluid circulating in the threads and peripheral sac; this he calls enchylema. 3rd. The granules, or microsomata, scattered in the hyaline mass and involved in the movement of the enchylema. Since then the terms hyaloplasm and microsomata or simply microsoma, were used by nearly all authors; but enchylema was considered as belonging to the hyaline protoplasm. When these distinctions became finally established, a greater confusion arose in the terminology, and

1 Pheffer (1877) had used this term in an entirely different sense.

protoplasm was almost ruled out of existence. We know already what meaning von Mohl had attached to the term protoplasm; but in the eyes of Max Schultze protoplasm was synonymous with "cell-body," and by this he understood the peripheral layer, or utricle of von Mohl; still other authors took protoplasm as synonymous with periplasma and ectoplasma. With Kupffer in 1875 protoplasm was only the fibrous network (reticulum), the rest of the protoplasmic mass he called paraplasma, and Strasburger (1882), committed the opposite mistake of making the meaning of protoplasm too general, for he called protoplasm all that has life in the cell, *i e.*, protoplasm, nucleus, chlorophyll bodies, etc., (by right he should also have added the cell membrane for it too has life). The end of all these distinctions was that there was no distinction left between protoplasm and the cell, and therefore cell and protoplasm should be considered as synonyms.

This was not all, for some writers began to use their own terms for that of the classic one of protoplasm; chief among these we find Haeckel (who is always fond of introducing something new) and Kölliker (1862) who employed the term cytoplasma. But enough about this abuse of terminology. The scientists had imitated the philosophers, and were quarreling about words, and Laneseau justly censures this state of affairs in the following words: "Nothing is more indeterminate than the meaning of the word 'protoplasm;' in fact, every author uses it in his own sense."

The quarreling about the meaning of words had drawn away the attention of observers from the real point of interest, viz. the structure of protoplasm, and in the heat of discussion over trivial points, most authors even did not suspect that structure and organization to exist which Dujardin had foreseen. No doubt however, cells having a visible structure had been known and had even been observed since the time of Fontana, as for example, muscular cells, epithelial cells, nerve cells, etc.; but their structure was regarded as proper to these cells only, a result, so to speak, of adaptation to their peculiar function. In 1859 Stilling had discovered a fibrous structure in the ganglionic cells of nerves, and in 1864 Leydig observed the same structure in the epithelial cells lining the interior of the intestines of the *Oniscus* and other allied crustaceans, but no one attached any importance to these discoveries.

It was Fromann who in 1865-1867 called attention to this fibrous structure, and he at once concluded that it must be a general property of living matter to be thus organized; in 1873 Heitzmann reached the same conclusion. These views were generally received with disfavor; and this with a show of justification, for some of the assertions were of such a nature as to bring discredit upon those who made them; their observations evidently were not extensive enough to warrant such sweeping generalizations.

Fromann, Arnold, Klein, Kupffer, Schmitz, Flemming, Rauber, etc., by new observations corrected many points at issue, but never was there reached a definite conclusion as regards the structure of protoplasm; in fact, the study of this structure has only begun, and to the future belong the honor and the task of elucidating this most intricate question in Cytology.

CHEMICAL CONSTITUTION OF THE CELL.—During this, the third period, the study of the chemical properties of protoplasm has made great progress. Microchemical researches are constantly multiplying and become more and more extended. A glance at the numerous chemical reagents in a laboratory of Cytology will convince anyone that there is real progress going on in this line. Prof Carnoy enumerates seventy-four chemical and coloring reagents aud preserving fluids, and judging from the date of their discovery, which he is careful always to give, we may safely conclude that microchemistry has steadily advanced since 1865, and already the happiest and most successful results have been obtained, and this chiefly by means of the many new coloring reagents. We may safely predict the future success in biology to rest on the steady advances made in microchemistry.

Macrochemistry also has not been neglected. The various tissues of both animals and plants have been analyzed; already the albuminoids, lecithin, cholesterin, the soluble ferments, the carbohydrates, the natural coloring matters, especially chlorophyll and hæmoglobin, etc., have been the special objects of investigation, as may be seen by referring to the "Physiological Chemistry" of Hoppe-Seyler.

In 1879 Prof Carnoy gave the following as a résumé of the chemical constitution of protoplasm: "Protoplasm is a complex mixture of various chemical elements. The most patient and most minute researches during the latter years have dis-

covered that typical protoplasm, such as is found in young and active cells, consists of the following substances, which henceforth must be considered as essential elements in living matter: Albuminous matter (vitellin or myosin, at least); phosphoric matter (lecithin and nuclein); one or several hydro-carbonates (glycose, dextrin, glycogen); soluble ferments (diastase, pepsin, emulsin); water (of constitution and imbibition); mineral elements (salts, sulphates, phospates, nitrates of K., of Ca., and of Mg.)."

Recently (1881) Reinke and Rodewald analyzed the plasmodium of *Æthalium septicum*, in which other elements besides the above enumerated, have been found; but possibly these were only accidental. The microchemical researches of Zacharias, 1881-1883, have revealed a new element of a protein nature, called plastin: and more recently even soluble ferments have been discovered which are called coagulating ferments. These ferments found in both animal and vegetable cells seem to be necessary for the accomplishment of certain phenomena of cellular life. But no doubt the most important work in microchemistry is reserved for the future.

STRUCTURE OF THE NUCLEUS.—As far back as 1859 Stilling had already called attention to certain zigzag, filamentous bodies in the nucleus. Fromann believed the appearance to be caused by strings and filaments crossing each other in their various ramifications; Heitzmann considers them as mere condensations of protoplasm; and in 1867 Hertig calls them "nuclear substance," and the hyaline substance between them he calls "nuclear sap." Flemming found however that these bodies form a real network, called reticulum, and that it is this reticulum that is colored particularly by staining fluids, which fact at once proves its non-identity with the surrounding protoplasm, an observation which in our opinion is correct. In 1879 Flemming calls this substance of the reticulum chromatin, and the part not affected by the same coloring reagents he calls achromatin.

Miesher, in 1871 made an important discovery, which marks an epoch in the history of the microchemistry of the nucleus; he found in the cells of pus, a particular substance to which he gave the name of nuclein, and also called attention to the most noted properties of this substance.

Prof Carnoy at once saw the importance of this discovery,

and especially of the solubility of nuclein in dilute alkalies and concentrated acids; and in 1879 even before Flemming had used the term chromatin he had already expressed his opinion which considers the coloring substance in the nucleus as none other than the nuclein of Miesher, and he has, since 1879, employed this term in his laboratory at Louvain. In 1881–82, Zacharias arrived at the same conclusion and by the same means. Most authors who follow Flemming regard the reticulum or chromatin as fibrous, and as a typical structure of the nucleus, but Balbiani in 1886 remarked in the larvæ of *Chironomus*, that the coloring part of the nucleus is a continuous tubule, and quite naturally suspected this to be the case in all nuclei, and this Strasburger in 1882 affirmed, although his observations were limited to a few nuclei of vegetable cells.

Rauber in 1882 states that the chromophilous part of the nucleus may present a reticulate, a filamentous or a globoid form. Outside of this reticulum or, more correctly, nuclein tubule, according to all modern authors, if we except Zacharias, there exists also a sap, or homogeneous fluid, which is very aqueous, without granules, or any other bodies of a particular shape (this is the achromatin of Flemming, the "Kernsaft" of others), and often there are to be seen in this fluid one or more nucleoli, the nature of which as yet remains to be determined.

With regard to the membrane of the nucleus there are many contradictory opinions; Peitzer, Retzius and Brass deny its existence, others who admit it consider it with Flemming as belonging to the nucleus proper, either as depending on the chromatin or not, and others with Strasburger regard it merely as a condensed layer of the surrounding protoplasm. In 1883, Prof Carnoy in the Prospectus of his treatise on Cellular Biology calls attention to another element existing in the nucleus; besides the nuclein he affirms there is also a true protoplasmic portion, consisting of a real reticulum and enchylema similar to those of the protoplasm outside of the nucleus. The structure of the nucleus, however, remains still buried in darkness, and in 1883 Rauber declares it to be still a scientific puzzle.

In 1884 appeared the first text-book of Cellular Biology, by Canon J. B. Carnoy, Professor of Cytology at the University of Louvain. I learn from the author that the first edition is already out of print, and the work is not yet completed. C. S. Minot,

under date of August 6th, 1886, in "Science," calls it the best treatise on the organization of the cell; and evidently the appearance of this work marks an era in the science of Cytology. But since the appearance of this treatise much has been done in Cytology by Canon Carnoy and by his disciple M. G. Gilson, and their observations and researches have been published in the revue called "La Cellule."

I reserve for myself to speak of these in my concluding article. For as I have chosen Prof Carnoy as guide in these studies, and for the most part let him speak for himself, I wish to follow him also to the end of his studies. By thus making known his researches to the American public, the author of these papers believes that he is repaying with gratitude the kindness shown to him by the professor, whilst studying under him in the Cytological Laboratory at Louvain during the years of 1881 and '82.

THE POLARISCOPE.

JOHN M. HOLZINGER, PH. D.

A STICK thrust obliquely into a vessel appears abruptly broken at the point of contact with the water. A penny lying in an empty dish and just concealed by the side of the dish from one looking obliquely into the bottom, will come into view if the dish be filled with water. Light travels in straight lines, but only so long as the medium is of uniform density, or so long as the light falls perpendicularly on media of different density. An oblique ray is bent from a perpendicular passing into a rarer medium; on passing to a denser medium, it is defected toward that perpendicular. And the above well known phenomena illustrate refraction.

Now, all the transparent substances met with in our experience, as water, air, glass, do thus deflect the rays of light. Some less common transparent solids, always crystalline, modify light in a more unusual way. If we could replace the water in the dish by Iceland spar, the penny would again appear above the edge, but it would now seem to be double. This mineral thus possesses the property of double refraction. The two rays, resulting from the splitting up of one, emerge from the crystal still more remarkably modified; both now are polarized, the one following the ordinary law of refraction being known as the

ordinary ray, the other as the extraordinary. While the other waves of ordinary light are probably of various forms, principally circular, the waves of polarized light are in straight lines at right angles with the path of the ray, and lying in a plane or parallel plane. In case of the two rays resulting from double refraction the vibrations of the one are at right angles to those of the other.

Light is polarized also by reflection from smooth surfaces not metallic. The angle of incidence, or polarizing angle varies for different reflecting substances. This is polarization by reflection; the other, polarization by refraction.

The most convenient and desirable form of polariscope for the microscopist consists of two Nicol prisms. A Nicol prism is a rhomb of Iceland spar cut by a diagonal plane and re-cemented with Canada balsam. The effect of this oblique stratum of balsam is to reflect to the side, and eliminate entirely the ordinary ray; so that only the extraordinary passes through, all uniformly polarized. Now, to the unaided eye, this light appears just like ordinary light. How, then, can we distinguish polarized light? If we take one of the mounted prisms, and look at the clear sky, avoiding, however, the direction of about 90° from the sun, little if any difference in brightness will be observed on rotating the prism while looking through it. But if the other prism is imposed upon it, and one of them is rotated, there will be found two positions 180° apart, when all light is cut off, and the field of view is black; and the light is brightest half way between these two points. One of these prisms is made to go under the stage, and is the polarizer. The other, the analyzer, generally goes between the objective and tube; or in the Griffith Club microscope it may be fastened to the lower end of the draw tube, in which case it is more convenient to rotate the analyzer than the polarizer, as is usual. In this position, the foregoing experiment may be more exactly made. And polarized light from any source may be detected in a similar way, by examining with one Nicol prism.

Such a prism, then, may be imagined to be a sieve with all the wires parallel, the cross wires being left out; so that only those vibrations continue which are in the direction of the spaces between the wires. If now the other prism is placed over it with the faces parallel, the polarized rays will still pass through un-

impeded. This is still true when one of the prisms is rotated 180° around from the first position. But at 90° between, on either side, total darkness results, since then we have to imagine two sets of parallel wires, at right angles to each other, so that all other vibration is stopped.

In themselves, these phenomena are not very interesting. But if different transparent objects, as scales of mica, or other thin sections of transparent minerals, thin sections of plant or animal tissues, starch grains, wool or cotton fibres, drops of chemical salts evaporated on glass slips, old lard, and similar substances be interposed between the polarizer and analyzer, and one of the prisms be then revolved, a display and shifting of colors is then observed which in exquisiteness and dazzling beauty surpasses anything ever seen with the naked eye. For most objects, especially the preparations of chemical salts, a $\frac{3}{4}$ inch objective is satisfactory. While for such as vegetable thin sections a $\frac{1}{5}$ objective is desirable. Among the latter, the cross section of a *Nuphar* stem makes a fine object. Some of the most satisfactory preparations of salts are salicin, santonin, tartaric acid, cream of tartar, cadmium bromide and sulphate, potassium ferrocyanide and citrate and rock candy. Salicin requires to be crystallized from a hot solution. Deliquescent salts, as calcium chloride and nitrate, should be warmed on the side, when the process of crystallization can be well observed. Such remain as liquid drops on the slide for a long time, and can be repeatedly heated. Those salts which effloresce make preparations of only short duration. Some salts, especially of ammonium, evaporate sooner or later. But many of these preparations keep well for months, even without cover glass, if protected from moisture and dust. It should be added that some salts, as the chlorides of potassium, sodium and ammonium, give no play of color. Also the crystals of colored salts, as potassium permanganate, copper sulphate, generally do not change color. Of the natural minerals, thin sections of gneiss, granite, marble, gypsum, hornblende, and agate, are among the most brilliant polariscope objects. But here it must be remembered that there is a maximum and minimum thickness, varying with different minerals, outside of which this play of colors cannot be produced. Thus sulphate of lime may have a minimum thickness of .425 mm., and a maximum of 1.27 mm. Mica must be at most .85 mm. thick; crystalline

quartz sections, at most .45 mm. It is difficult to get colors with sections of Iceland spar itself, because the thickness of the section must not exceed the one-fortieth part of a millimeter.

Thus, while we have in the microscope itself an instrument for revealing a wonderful variety and beauty of form hidden to the naked eye, the polariscope reveals matchless beauty of color, of which no microscopist, no teacher of the youth, in fact no one, can afford to be ignorant. These phenomena are of surpassing interest in themselves. And the chief object in writing this paper is to direct to them the attention of all concerned. It would lead into deep water, and would be far from interesting to treat here more fully of the laws of crystallization, the optical properties of crystals, the intimate relation of the force of crystallization and of light as suggested by the phenomena of the polariscope, unless the reader be first familiar with the facts. Those interested will naturally go to the higher works on this subject. The writer has access only to Deschanell's Natural Philosophy, and to a French work by Guillemin, "Les Phénomènes de la Physique," both very helpful to a good understanding of this subject. But first of all—facts; let every one who can afford it get a polariscope and set about seeing these things for himself.

Finally, a word about the practical uses of the polariscope. So far it has figured as only an exquisite toy, or by suggestion at most as an aid in unravelling the mysterious nature of light and its relation to chemical force and cristallization. Perhaps in this same category may be placed the first use here to be mentioned, namely that of determining whether bodies like the planets and the moon shine by reflected light or are self-luminous. For reflected light, being polarized, if examined through a Nicol prism, will darken the field of view at two points 180° apart. Then the play of colors in certain of the plant and animal tissues, show that the cell walls in these tissues are doubly refractive. As Arago has shown, the jeweler may use the polariscope as a test of precious stones, by measuring the polarizing angle on one of the ground faces; for instance, that of the diamond is 67°–70°, of flint glass, 57°–58°. So also, in crystallography in general, the polariscope enables us to distinguish crystals with one or two axes and to determine their position. Further, in the investigation of sugar adulteration, or saccharimetry, this instru-

ment is invaluable, for by it the proportion of pure sugar in a given solution can be detected. Lastly, a Nicol prism, so adjusted that the principal section is vertical, will absorb the polarized rays reflected from the surface of water and thus submerged objects, ahead of a vessel at sea, are made visible by the refracted rays from those objects.

If after reading these lines some few take interest in the polariscope, the writer will feel amply repaid. We must not expect to become a Nicol, a Huygens, a Malus, a Biot, a Brewster, or a Fresnel. But after we have used the polariscope we shall at least delight in thinking after these men their thoughts on the abstruse subjects that cluster around polarization.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XVIII.

THE USE OF THE STAND.

IT is well for the observer to keep both eyes open when using the microscope, and if he begin with this plan he will be doing well, for it is somewhat of a trouble at the start to see anything in the microscope with both eyes open, as the unemployed organ seems to dominate. At first the images of the objects on the table and of the object under the microscope will mingle, but as combination is impossible the result will be amusing and annoying. At one moment the magnified image will have the mastery, at the next the macroscopic objects will dominate the view, and at times the eye will fail to take cognizance of anything. But with a little practice the result is entirely satisfactory, and the brain will finally take notice of the magnified image only.

It has been suggested that instead of allowing the unoccupied eye to roam about aimlessly as it does, and as may be noticed when another person is at the microscope with both eyes open, it would be better to give it a dark surface to gaze at, or, as some recommend, a white surface. Consequently many forms of eye shades have been devised. They are all applied to or near the eye-piece, a projecting arm carrying a disk for the protection of the unoccupied eye. Mr Edward Pennock of the firm of Messrs J. W. Queen

and Co., has proposed a form made of brass and applied beneath the cap of the eye-piece. Dr R. H. Ward, of Troy, N. Y., has also devised a form which is light in weight, being made of hard rubber, and easily used, as it is not applied to the eye-piece, but to the top of the body tube, so that the ocular may be changed without removing the eye-shade. By simply turning it over it may be used before either eye. Messrs Bausch and Lomb manufacture it. Both of these are useful and commendable, but Dr L. B. Hall of Philadelphia, has described another device for this purpose that may be made at home.

Dr Hall's eye-shade consists of a small opaque disk supported by a wire extending from its outer edge downward to a point on the tube low enough to be out of the way of the nose, then bent upward parallel with the tube, but not touching it, and attached to a ring near the top. His own was made of No. 18 brass wire about twenty inches long, with a loop about $1\frac{3}{4}$ inches in diameter at one end and covered with black paper to form the disk. The other end is made into a ring to fit the body tube, and the intermediate wire is bent as described. The ring about the body may be covered with chamois skin if desired, to protect the lacquer.

Having placed the microscope in position, with the object in place and the field well illuminated, the microscopist has only to sit at his ease and pursue his investigations. How he shall study the object depends upon that object and upon the idiosyncrasy of the microscopist. It cannot be taught in these chapters which treat the subject only in a general way. But, the investigation finished, the instrument must be returned to the case and cared for carefully. No machine, and no instrument of any kind, will take care of itself. The owner must attend to its wants and needs, or neglecting these, he will pay the penalty in the instrument's decreased usefulness and service.

To return the microscope to the case demands movements the reverse of those used to take it out. The body is racked up, the objective unscrewed, taking care not to drop it or to strike it against any hard substance, and it is then gently replaced in its brass box and the lid screwed on. The slide is taken from the stage, and if permanently mounted, is returned to its proper cabinet; the mirror is returned at right angles to the optic axis of the instrument; the eye-piece is removed and deposited in

the receptacle prepared for it; the body is racked down, and placed in a vertical position, and the stand is lifted into the case, where it remains with its front looking at the back wall of the box. The door is then closed and locked. If there are children around that cannot be controlled, the key would better be carried in the owner's pocket. Two minutes' brutal usage will do more injury to a good stand than months of proper treatment. No one but the microscopist should ever touch the objectives, and he should carefully avoid the contact of his fingers with the lens. Optical glass is soft and easily injured. The owner would do well to act accordingly, for a scratched or broken objective is a ruined one.

Dust is an insidious and a dangerous enemy to the microscope. It gets into the bearings and the movable parts, and harms them. The microscopist should therefore often wipe the stand with a soft old handkerchief or a fine chamois skin. The latter is the better since the fibres from the handkerchief often become a source of trouble. No liquid should be used; alcohol should especially be avoided as it will remove the lacquer. The rack and pinion bearings may be occasionally and sparingly touched with the porpoise oil used by the jewellers, or with very superior sewing-machine oil. Exceeding small quantities must be used, and the parts at once wiped almost dry, otherwise the oily surfaces will collect the dust, and the last state of that microscope will be worse than the first. The dealers use soft and thick grease for lubricating purposes, or a refined tallow. The parts of a well made stand need lubricating only at very long intervals. They will work well if kept perfectly clean and free from dust.

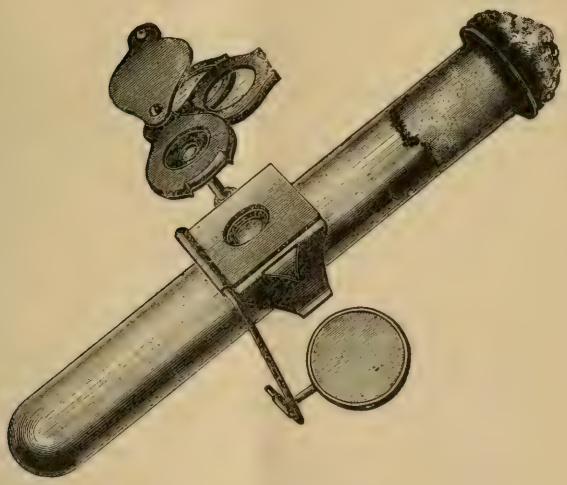
The microscopist will sometimes be annoyed by one or more indefinite specks or spots apparently in the field, but whether on the eye-piece or on the objective he cannot decide. That they are not on the object or the cover glass is determined by moving the slide, and if the specks remain stationary they are either on the ocular or on the objective. To discriminate between these, rotate the ocular; if the offending particles move they are on it; if not, they are on the objective. If on the former, the two lenses may be unscrewed and carefully wiped by the Japanese filter paper; if upon the objective the front lens may be guardedly touched with the Japanese paper, or the back combination very cautiouly swept with a soft camel's hair brush. This must be carefully done, and the brush must be scrupulously clean, other-

wise the glass may scratched. In all these operations the breath is a useful and a harmless assistant.

There are often found on a slide three objects that perplex the beginner. These are air bubbles, oil drops and that quivering and apparent dancing of minute particles called the Brownian movement, or pedesis, or sometimes the pedetic motion. Air bubbles have been described as wonderful things. I remember to have once shown a slide of urinary deposit to a physician, who immediately cried out that the patient must be in a dreadful condition, for those big, round black-bordered things surely must be deadly. Like the majority of persons unaccustomed to microscopical investigation, he had gazed at the most prominent object in the field, and not at what I wanted him to see, for he had looked at two or three air bubbles, that are of a truth rather frightful to the uninitiated. In such cases an indicator in the eye-piece is a useful contrivance.

A COLONY COUNTER.

J. EDW. LINE, F. R. M. S.



IN the study of the comparative biology of water supplies, sewage, infusions, secretions, etc., it is necessary to fix the organisms in a nutrient medium, cultivate them to a given limit, and make a count. To do this neatly and effectively two pieces of apparatus are requisite, an Esmarch tube and a colony coun-

ter. Glass plates and a linen prover have heen made use of, but for more accurate results other and better means are called for. The Esmarch tube is simply a test-tube evenly coated internally with solid, sterilized nutrient medium—agar-agar, gelatin, combinations of the two, etc.,—and stopped with cotton. The coating is done by pouring into the tube a quantity of medium, tipping and turning the same until no part of the surface remains untouched, except of course that in the immediate vicinity of the cotton stopper. When the medium has been thus evenly spread, the tube is immersed to the neck in ice water, and then stored for future use. Some roll the tubes on ice, but the medium hardens and sets unevenly—in lumps, ridges, etc.—a condition of things likely to vitiate the count.

In making a comparative determination a series of tubes are taken, a given quantity of the material under examination put into each one, "swashed" about and the surplus thrown out, or by means of gentle heat (not however always advisable), incorporated with the medium. At the end of a given number of hours or days, a count is made, the count repeated at intervals, the results recorded, and if it is desired to experiment further a cultivation begun.

At this stage of the examination the counter comes into play. It is simply a small microscope adapted to tube examinations and consists of a modification of a brass knife-clamp that grasps the tube, holding it firmly to the under side of the stage, the opening in which contains a cover-glass divided into square millimetres, or in a more recent and better form, an opening in the stage one by four millimetres, the greater diameter running lengthwise with the tube. The optical part is an "Excelsior" triplet, the lenses of which may be used separately or in combination; the adjustment is frictional. The substage has universal movements, and may be readily detached if window or lamp light is preferred direct. The Bausch and Lomb Optical Company make the instrument.

THE leaves of Hemlock as well as those of several other evergreens, have on their lower surface one or more silvery white lines plainly visible to the unaided vision. If the reader has never investigated these, even with a pocket lens, he has in store a pleasant surprise. On the leaves of certain of the Coniferæ this silvery deposit is visible, even to the unaided vision, as minute white dots on both surfaces of the leaf, but with the majority, with the Hemlock especially, the appearance is that of a smooth and continuous little sheet of silvery whiteness. To the pocket lens this deposit becomes a surprise inasmuch as it is resolvable into minute dots disposed in somewhat regular sequence, and with some show of order in their arrangement. As a rule these white specks are in lines parallel with the length of the leaf, and at regular intervals from one another. At once the question arises, What are these little dots that make the lower surface of these Hemlock leaves so silvery? The pocket lens is silent on the subject. Remove a leaf, place it under the compound microscope with the lower side directed upward toward the one inch objective. Then illuminate it with a strong reflected light either from the concave mirror rotated above the stage, or by the bull's eye condenser.

Arranged in three or four parallel lines on each side of the midrib are what appear to be microscopic snow-balls clinging to the leaf, and in several places seeming to have extended over the surface in a delicate film of white. In no spot do these little balls of fairy snow touch each other. Each is as distinct and as well defined as were the snow balls that we once made when we were younger and attracted by winter sports. You made your snow balls, and rounded them well, and piled them in a row so that they should be convenient, and so that not one should come in contact with any other. So are these little balls of what seem under this illumination to be spherules of vegetable snow. On both sides of the midrib of the leaf they lie in lines that are

straight and distinct, while in the older leaves a film spreads widening and extending over the surface somewhat irregularly yet without disarranging the little heaps themselves, or without taking any part of their substance. If you should go no further than this in the examination you will have seen a beautiful thing in the common Hemlock leaf, and one that can be examined at any time without the least trouble. But having progressed thus far, the subject will become interesting and the microscopist will determine to know what these things are, and if possible where they came from.

With a sharp razor cut away the projecting midrib, and then make some free hand sections of the leaf, cutting the silvery layer from the surface to which it is attached. Mount the sections in glycerine, and examine them by transmitted light. What has become of those white balls? They are now represented by little dots of opacity so dark they are almost black. Rack up the condenser, if necessary, and get a strong light on them. Still in the regular order and that evenly distributed sequence. A sudden thought will perhaps strike you as you are looking and wondering what these common leaves have got to tell. What secret has here been waiting all these years since you have had a microscope and since you have almost every day been passing this Hemlock hedge? You have of course noticed the green and tender leaves appearing in the spring; you have observed that they change color and lose their delicate tint as the season advances, and you have taken the leaves into your hand and have seen the silvery lines on the lower surface, but that is all. You have perhaps never thought that these lines of whiteness might be anything but a colorless portion of the cuticle. Now this must be investigated.

While you are looking an idea leaps through your mind, and you set about proving it. But how? The dots are too small to be picked off with a needle point. When scraped away with the knife the result is microscopical chaos. What can be the character of the substance? It is not resinous in the ordinary botanical sense of that term, for it is not sticky to the touch. It must be something analogous to the bloom on the plum, on the cabbage leaf and others. Then it should be wax. If wax it is susceptible to heat. No sooner thought of than executed. Over the lighted lamp goes that section for the fraction of a minute.

When cool enough not to endanger the objective it is again slipped beneath the one inch or higher power.

This is a revelation. The microscopic balls of snow have disappeared and in their place are as many little drops of liquid as yet unmiscible with the glycerine, and most astonishing of all, each drop of liquid is clinging to the edge of a stoma or breathing pore of the leaf. Can it be that the little balls that compose those silvery lines are each adherent to a breathing pore? With rather feverish haste under the excitement of a possible discovery, the microscopist makes another section, and treats it to a hot bath more prolonged than was the first. Now the waxy accumulations and the liquid from their melting have entirely disappeared, and the stomata stand out clear, clean and sharply defined.

It seems that each stoma has been heaped above the brim with this deposit of white wax. Each breathing pore is somewhat depressed below the general surface of the leaf and this little cavity is filled to overflowing with the waxy secretion. This fact suggests other questions. If, as is undoubtedly the case, the stomata are filled with the deposit, how then does the air gain an entrance to the tissues of the leaf? In some instances that are few and must be searched for, there are minute channels through the wax balls that may be large enough to admit all the oxygen that is necessary and to allow the stomata to fulfil their purposes. How that may be I do not know. I only know in this connection that the breathing pores are piled full of the secretion and choked with it, and that the judicious application of heat to the glycerine surrounding the section removes it, leaving the stomata as clear and distinct as they were before obscure.

But where does the secretion come from? Is it exuded by the guard cells of the stomata, or is it formed by the cells enclosing the air chambers beneath the stomata and into which they open? If the latter, then the wax must be pressed out through the opening between the guard cells to be heaped up in the little balls that together form the silvery lines on the surface. Here is a question for the investigating reader to answer. Transverse sections of the leaves of the Hemlock or of other evergreen trees will tell the story. The thin, irregular film on the general surface of the leaf is probably secreted by the cells of the epidermis. But this is also a question for the razor to settle.

N. B.—The Editor of THE MICROSCOPE edits the magazine. He is not in charge of its business affairs. These are in the care of Lucas & Co. Business letters should therefore not be addressed to the Editor personally.

ACKNOWLEDGEMENT.—To Mr Fr. Dienelt, Loda, Ill., for several mounts of insects and of their isolated organs.—To Dr J. G. Meachem, Racine, Wis., for a slide of *Trichina spiralis* from the human diaphragm. For numbers and size these surpass any of the kind that I have previously seen, a field of the one inch objective containing thirty large worms. Imperfectly cooked sausage was the means of introducing the Trichinæ into their victims.

The American Society of Microscopists will hold its fourteenth annual meeting, Aug. 10, in Washington, D. C., under the presidency of Dr F. L. James, of St. Louis. It will continue in session for five days.

A FEW HINTS ON THE EXAMINING OF SPUTA FOR TUBERCLE BACILLI.

DR C. F. GARDINER.

When, in 1882, it was heard that Dr Koch had discovered the micro-organism that caused consumption, it was hoped that by a step further, he or some one else would give to the world a method by which this micro-organism could be destroyed. Although this has not as yet been accomplished, much good has been done by this discovery as it has enabled physicians to detect consumption at such an early stage of its course that prompt measures will often stop it. This is indeed a triumph of the microscope and one of which microscopists may be justly proud. I have endeavored in the following to give, in as short and practical a manner as possible, the whole process of the microscopical examination of the sputa for the tubercle bacilli.

I have also mentioned the formula of a comparatively new staining process, which I think is more rapid and simple than any I have seen generally published.

The tubercle bacilli are about half the diameter of a red blood corpuscle in length, so a good power is required to see them; at least a one-sixth objective, a good eye-piece and condenser are necessary. Strong white light should be selected, such as that from a north window or a student lamp.

To collect or to keep sputa it is not necessary to use bottles. Ordinary paper pill boxes of large size painted inside with two coats of shellac will answer all requirements, and can be mailed, if necessary, or destroyed by fire and cost but little. To keep sputa for several days, add a few drops of a ten per cent. solution of carbolic acid.

The first sputum expectorated in the morning, is the best to examine. First hold a needle (an ordinary needle stuck in a small stick will do), in an alcohol flame until red, then cool and with the point pick up a small bit of sputum. The white lumps are the best to select for this purpose. Spread the sputum as thinly and evenly as possible on the cover glass and let it dry in the air, then take it in forceps by one corner and pass it through the top of an alcohol flame, sputum side up, three times with the pause of a few seconds between each time; pass it through the flame about as fast as one would cut bread. It is now ready to go into the staining solution. The following staining and decolorizing solutions are now quite largely used in Germany and were shown to me by Dr Prudden of New York, and after having used them almost daily for four years, I can recommend them as practical and rapid, provided fine dyes are used, such as made by Prof Grublers. These can be obtained at Meyrowitz Brothers, 23d Street and 4th Avenue, New York.

Sol. No. 1—Fuchsin,..... 15 grains,
Alcohol,..... 2 drams,
Carbolic Acid,..... 1 "
Water,..... 2 ounces.

Add the alcohol to the fuchsin and shake well until it is dissolved, then add the carbolic water.

Sol. No. 2—Methyl-blue,.....15 grains,
Sulphuric Acid, C. P.,.....1½ ounces,
Water,.....1½ ounces.

Add the sulphuric acid and water (after cooling) to the methyl-blue.

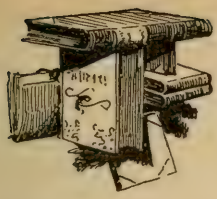
These put up in bottles and marked 1 and 2 can be kept for a long time.

The cover glass is now immersed in solution No. 1, or the carbol-fuchsin, for three minutes. It is then taken out; the excess of red washed off in water and immersed in the No. 2, or blue stain, for two minutes; if at the end of this time it is still tinged with red, it can be put back in the blue for another minute or so; it can now be washed in water, and examined either in a drop of water or dried and examined in Canada balsam. If the specimen washes off the cover glass it is because it has not been flamed enough, or the sputum has been deficient in albumen. To find the bacilli, look for small bright red rods. Everything else will be found stained blue. Look at the thinner places and the shores of the blue islands, as it were. When there are but few bacilli in the sputa, seven to ten cover glasses may have to be examined before they can be detected. The fine adjustment should be constantly used so as to bring into focus any bacilli which may be in the field.

It will be noticed that in using these stains no heat is needed, and the whole process takes but very little time.

PRESERVATIVE FOR ALGÆ.—After quoting the Hon Nicolas Pike's preservative as published in THE MICROSCOPE, the *Bulletin de la Société Belge de Microscopie* says that M. Ripart employs for the preservation of fresh water Algæ, such as *Spirogyra*, *Zygnema*, solutions of the carbolate of soda, 1 part to 1000, and 10 to 1000. The first mentioned serves for the preservation of the plants in bulk; the second for microscopical preparations in glycerine. To obtain a satisfactory result he recommends that the Algæ be well washed to free them from extraneous matter, and placed in bottles completely filled with the carbolated liquid.

STAGE IMPROVEMENTS.—When the stage is perfectly even, the slide will always bear on it with the whole surface, and not move with sufficient ease. This can be remedied by copying a feature of the Zentmayer stage, and in some way fixing two rails or narrow strips of metal on which the slides move with remarkable ease. HANS M. WILDER.



NEW PUBLICATIONS

ARTIFICIAL KEYS TO THE GENERA AND SPECIES OF MOSSES recognized in Lesquereux and James' Manual of the Mosses of North America. By Prof Charles R. Barnes, Madison, Wis. 8vo., pp. 81. Price 50 cents.—The Manual mentioned in the foregoing title contains a key to its contents that to the ordinary student is simply demoniacal. Prof Barnes seems to have recognized its difficulties and its short-comings, and has therefore prepared these tables to the genera and the species. I have not had an opportunity to put his work to the test, but I hope he has not hesitated to make it artificial. An examination without a specimen in hand seems to show that he has, to a certain extent at least, yet like most advanced botanists, he can hardly force himself to do what to the learned teacher appears almost like sacrilege. Every arrangment of the kind, if it is intended to help the student that is working without other aid, should be as artificial as possible. It is this character that makes such tables important and useful. Prof Barnes seems to have done well. If he has discovered the importance of artificial points the result will be a boon to the student that may not be an expert in the study of mosses. The keys are worth a trial, and since it is the mosses that are involved, a prolonged trial should be made before condemning or criticising.

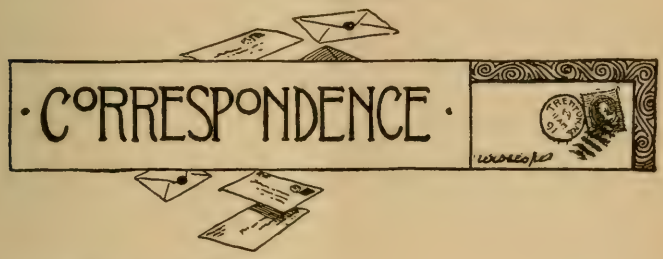
INSECTA. Guides for Science Teaching, No. VIII. By Alpheus Hyatt and J. M. Arms. Square 16mo., pp., XXIII., 300. Boston: D. C. Heath & Co. Price $1.00.—This is a refreshing and a stimulating little work, and therefore as unlike as possible some manuals of entomology that seem to take delight in slapping the face of the student that has the audacity to consult them. Such books appear to feel a fiendish glee in refusing to answer simple questions that the authors should take an angelic delight in answering. Prof Hyatt's "Insecta," is a series of replies to questions that have arisen in the mind of the author while teaching, and the book succeeds in telling the reader many things that he

wants to know and cannot easily learn elsewhere. It shows how the specimens should be studied, explains the appearance of their several parts, their structure, and their function as far as is known. An exceedingly commendable feature is that in foot notes the reader is told where he may find the subject treated more extensively, so that he may make himself familiar with the recent researches of English speaking entomologists, for most of these references are to accessible literature in our own language. The illustrations that really illustrate are numerous and beautiful.

PHYSIOGNOMY AND EXPRESSION. By Paolo Mantegazza. 8vo., pp. 224. New York: The Humboldt Pub. Co.—This book may be read with satisfaction even by those that believe that physiognomy is a kind of occult art possessed by few, and worthless when those few attempt to explain its principles and to teach their application. That there is a foundation of useful facts in the vagaries of the advancing physiogomist no one will be disposed to deny, but that the thoughts of a man's soul and the condition of his physical functions, are written on his face and in his eyes, are claims to be laughed at. The author says that he has set himself the task of separating positive observations from the number of bad guesses and ingenious conjectures that have encumbered the path of the study. "My wish has been to render to science that which is due to science, and to imagination that which is due to imagination." But after the imaginary parts have been eliminated, science has but a sorry showing for her share of the spoils. Yet the book is interesting, and worth reading for the sake of studying the extremes to which an unbridled imagination can go. Many of the fantasies of former writers Senator Mantegazza ridicules without mercy, and thereby makes his book exceedingly suggestive.

PRACTICAL POINTS IN THE MANAGEMENT OF THE DISEASES OF CHILDREN. By Dr I. N. Love. Physician's Leisure Library Square 16mo. pp. 141. Detroit: G. S. Davis. Price 25 cents.—This is a delightful little volume by an author in love with his subject, and expert in the management of the diseases of which he treats. He speaks as one having confidence in the value of his judgment and in the application of the results of his experience, and the reader soon feels a similar confidence in his

frank and manly recommendations. Dr Love has little respect for the ancient treatment and opinions still used and believed in by the routinists, and expresses his mind in an emphatic and characteristic way that makes the reading of his book very agreeable. His own methods commend themselves to one's reason, and carry weight as the experience of a specialist. It is to be regretted that he occasionally condescends to the use of slang; there are but two instances of this, however, yet these are two too many. Otherwise the book merits a cordial welcome.



EDITOR THE MICROSCOPE:—

As a matter of scientific interest to your readers I would like to make known the discovery of a deposit of infusorial earth, made near Montgomery, while strolling along the river bluffs observing the character of the various exposed strata. I noticed an outcrop of argillaceous earth, which upon examination with a small lens, suggested the possibility of its being a fossil earth; on giving it the requisite treatment, I was surprised to find it a pure diatomaceous earth, and as it happens, the first of its kind and character recorded as occuring in the Southern States. Its occurrence adds another component rock to the geological strata of Alabama, hitherto not noticed nor mentioned in any work treating of the geology of the State. I have barely examined the extent of the thickness of the strata, but it may be greater than four feet, and may likewise underlie a very wide area in the vicinity of the hill where its outcrop occurs. The numerous included species are similiar to forms already named from localities in the New England States, but as an entirely new source of the material it must in the future make Montgomery widely known, as diatomists in all parts of the world will want samples of it for their collections when its fame is spread abroad.

302 STATE ST., MOBILE, ALA. K. M. CUNNINGHAM.

EDITOR OF THE MICROSCOPE:—

In a recent chapter of "Amateur's" notes, we observe that he states that "If the physician wishes to make more delicate investigations with higher powers, or to enter even a little way into Bacteriology, he must seek a stand that shall be more complete in its sub-stage arrangements than is the Acme No. 4, as a sub-stage condenser cannot be added to it, and this accessory is now essential for even the least advanced worker." We hope you will allow us, to correct this statement, as we are constantly supplying these microscopes for bacteriological work, with an adjustable sub-stage condenser, rendering it admirably adapted for use with even the very highest power oil-immersion lenses. The workmanship, and delicacy of action of the adjustments being as perfect in this instrument as in the more expensive instruments, we highly recommend it for professional work with even the very highest powers, although undoubtedly a movable sub-stage affords an additional convenience or refinement for high-power work. Yours very truly,

PHILADELPHIA JAMES W. QUEEN & CO.

EDITOR THE MICROSCOPE:—

In Prof Seaman's article in the May number he mentions that Ann Arbor uses largely American microscopes, etc. This statement is both right and wrong. As everyone knows, the University of Michigan is without doubt a great institution, but its scientific departments, especially microscopy, are nothing to what they should be. Why? Because they are handicapped through want of means to an extent which is not and cannot be realized by anyone outside of the University. It tries with might and main, but cannot do the work it should, for most of the students are not wealthy, the number of good microscopes is very small, and the number of instructors inadequate in comparison to the students and in quality, for no good men can give their time and knowledge for the paltry sum paid, it being in many cases only sufficient for board and rooms with very little over. The microscopes are mostly foreign makes, as can be easily proved by reference to the catalogue: Zeiss, Beck, Leitz and a few by Bausch and Lomb; the majority of the latter I believe are the poorest stands and oldest patterns, not, let it be understood, through any fault of the firm, but because the University had such poor

stands in its histology department that I believe Bausch and Lomb very kindly looked up an old odd lot which they almost gave to the microscopical laboratory, and to them were added Beck's $\frac{1}{2}$ inch economic lenses which need no recommendation to tell their value for a cheap and useful lens. The other objectives are $\frac{1}{6}$ Beck, Zeiss and a few miscellaneous, as B. & L $\frac{1}{4}$ inch, not recent makes, and Gundlach. Bausch & Lomb have few stands in one of the laboratories, but the main outfit of lenses and microscopes are Zeiss, Leitz and Beck. If means were to be had, possibly Bausch and Lomb would be represented by their first class instruments, and Michigan could then claim a place in microscopical science. As yet, I think the main worker is Prof Gibbes, who chiefly uses Beck's instruments. My objection to the American stands is the heavy make, and the objectives being so large and heavy when compared with other makers, it being rather a strain on the adjustment to use a triple nose piece and three objectives. Personally I only care to use a light double nosepiece, but when working Histology or Bacteriology one really requires a triple combination. The objection given by many microscopists against the American makers seems to be the greater price paid for an objective which will barely or only just accomplish the work of a foreign lens. Personally, this seems to be hardly the case, the difference being, in Bausch and Lomb's, only slight, I believe. The great objection is the weight and size. I have seen Beck's $\frac{1}{2}$ and $\frac{1}{6}$ economic series do some very fine work, and far superior, considering the price, to the Leitz's $\frac{1}{5}$ homogeneous, Beck's $\frac{1}{6}$ dry which with duty is about $10.00, and in this country by many professors is so well thought of!! To many microscopists the two lenses of Beck are all that are necessary and the cost is very small. Bausch and Lomb's professional $\frac{1}{5}$ is a very good lens, and if the size was reduced their objectives would be of greater valve. The microscopes used in urinary analysis at Michigan are barely worthy of the name considering the instruments of to-day, and if the University could gain a friend interested in this work who would be able to assist it without having the Legislature reducing its grant on that account, microscopy and American microscopes would be the gainers, and fewer men leave for Germany and other countries to study this branch of science.

ANN ARBOR, MICH. V. A. LATHAM.

EDITOR THE MICROSCOPE:—

The February number of the Journal of the Royal Microscopical Society, London, has the following extract from M. A. Lune's Traite de Microscopie, 1889:

"RESOLVING POWER A SUPERFETATION.

Resolving power. We regret not to have the necessary authority to erase this word from the dictionary of microscopists, since it appears to us to constitute an entire superfetation. To say of an objective that it has resolving power is, according to most authors, to attribute to it the power of isolating, so to say, one from another the finest details of structure on the surface of a transparent object, such as striæ, fibrillæ, depressions, reliefs, etc.; but an objective which defines well in the complete sense of the word, ought it not to resolve perfectly?

This carries a long way further the error on which we commented in the case of the Quekett discussions, where, however, it was not proposed to abolish the term 'resolving power!' As we explained then, and shall probably have to repeat again, an objective may have perfect defining power, and yet, by reason of the want of aperture, it will be unable to show particular markings. It defines all that it can take up, but can not define what is not imaged by it.

It would be possible, no doubt, to arrange that the definition should be considered to include 'resolving power,' but nothing would be gained by confusing the two terms, especially as we have already the term suggested by Prof Abbe—delineating power—to denote the combination of the two qualities, an objective having large delineating power when it both defines well and has large aperture.

The author's views are in other respects peculiar, as he is of opinion that 'an objective of large angle, well constructed, will—all other things being equal—show details in depth as well as it will show those on the surface.'"

Thinking that you may not have seen and published this communication, and that it will be interesting to you and other microscopists, you receive this copy from,

Yours very truly,

DOVER, N. H. DR. CARL H. HORSCH.

THE MICROSCOPE.

AN ILLUSTRATED MONTHLY MAGAZINE.

VOL. XI. TRENTON, N. J., JULY, 1891. No. 7.

ORIGINAL COMMUNICATIONS

THE SO-CALLED MIGRATING CELLS OF THE CORNEA.

(WITH PLATE II.)

C. HEITZMANN, M. D.

IN the seventh decade of our century von Recklinghausen, now professor of morbid anatomy at the University in Strassburg, and Max Schultze, late professor of zoology at the University in Bonn, made wonderful discoveries concerning the mobility of the "cells" of warm blooded animals. Von Recklinghausen first constructed a moist chamber, in which, evaporation being prevented, the living cells could be seen to execute amœboid form-changes and locomotion; Max Schultze invented the so-called heated stage, on which the temperature could be raised at random, greatly facilitating the observation of locomotion under the microscope. A score of investigations afterward corroborated the statements of these two excellent microscopists.

Von Recklinghausen also was the first to assert that in the freshly excised cornea of the frog and of a number of warm blooded animals, if the cornea be placed in the aqueous humor, the liquid filling the anterior chamber of the eye, migrating

"cells" could be seen. They begin to appear, such was the claim, after the specimen has been left at rest for some time, and exhibit form-changes just as active as are those of the amœboid "cells" of the frog's blood. They migrate under the very eye of the observer in curved, sometimes straight routes, traversing the field of vision in about one hour. The number of migrating "cells" is considerably increased, if the cornea can be brought to inflammation by cauterization with nitrate of silver. Since 1864 the "cornea cells" in consequence of their discoveries, were divided into the "fixed" and the "wandering" ones, the former being embedded in the basis substance, the latter migrating in certain insterstices in varying numbers. Cohnheim, in 1867, announced the idea that all inflammatory or pus corpuscles have migrated into the tissue of the cornea from without, being nothing but colorless blood-corpuscles that have left in an active locomotion the cavities of the capillary blood-vessels. Such vessels, as is well known, exist only at the border of the cornea, whereas the substance of normal corneæ is entirely destitute of vessels of any description. It was especially the frog's cornea which served as a battle-field for the adherents of Cohnheim on the one hand and the opponents (F. A. Hoffman, S. Stricker and others), who proved that in inflammation the formerly "fixed cells," after having split up into a number of pieces become "wandering cells." At the beginning of the eighth decade there were three parties engaged in the fight regarding the origin of the "migrating cells," those who claimed that the sole source of such cells is the blood and blood-vessels; those who maintained their origin from fixed cornea cells exclusively; and those who admitted both ways.

The cornea is an extremely tough and elastic tissue, equal in its consistency to cartilage, as everyone knows who has tried to cut through it; that in inflammation the basis substance becomes softened, and admits of a locomotion of "migratory cells," soft protoplasmic bodies themselves, was intelligble. But how could we explain such locomotions in a normal cornea, or through the peripheral portions of the cornea, when the inflammatory focus, artificially produced, was in its centre?

For those who claimed that the cornea is traversed by lymph-channels, lined by endothelia, and holding, here and there, in a rather loose way, fixed cornea-corpuscles, the explanation of the locomotion of "migrating cells" could not be difficult. To

all observers, on the contrary, who were convinced of the absence of lymph-channels proper, these being filled almost entirely with branching protoplasmic tracts, the migration appeared as an almost inexplicable phenomenon. The possibility could, however be admitted that the creeping bodies find their way between the lamellæ of the cornea, which were connected by filaments traversing interstices of a certain width, although the presence of such interstices could not be proved in traverse sections through the cornea, stained either with chloride of gold, or nitrate of silver.

S. Stricker, professor of general pathology at the University in Vienna, in 1880 first made a startling statement as to the intimate nature of the "migratory cells." He denies the existence of lymph spaces in the cornea, since he takes the ground that all spaces are filled with protoplasm. He corroborates my assertion that in the living cornea both the cornea corpuscles and the basis substance are alive, that protoplasm may, at any moment, be transformed into basis substance, and the latter into protoplasm. He argues in the following way: Since there are but extremely narrow interstices between the cornea-corpuscles and the basis substance, there is no possibility of the migration of protoplasmic lumps, just as little as there is a possibility of moving a pea between the skin and a tightly fitting glove. Stricker claims that the whole doctrine of "migratory cells" in the cornea is a mistake. What von Recklinghausen described as amœboid and moving cells, were neither amœboid nor moving, but merely pieces of protoplasm which appear in the basis substance at one point owing to a liquefaction of the latter. This basis substance being dissolved in a succession of points, and reestablished in an opposite direction, the appearance of locomotion is conveyed to the observer. Stricker compares this process to a piece of wax spread out upon a plate, under which an alcohol lamp is slowly moved. Where the heat is most intense, the wax melts, whereas the cooled off portions soon become hard again.

When I read these assertions, I confess I felt much surprised, although they were in harmony with my own views, which I had held ever since 1874. All doubts, however, vanished from my mind when Stricker showed me the so-called migratory corpuscles of slightly inflamed corneæ of frogs, during my sojourn in Vienna in 1883. Neither do these bodies push forward

offshoots anteriorly, as we see on any creeping Amœba, nor do they retract offshoots posteriorly. In the direction of the forward motion blunt, slightly branching and light offshoots appear suddenly, which posteriorly fade away without ever being retracted into the main mass of the protoplasm. These offshoots are, therefore, nothing but protoplasm freed from basis substance anteriorly, and transformed into basis substance posteriorly, thus conveying the impression of locomotion.

Stricker in his "Lectures on General and Experimental Pathology," 1883, on page 838 describes the phenomenon in the following way: "The new offshoots may have all sorts of shapes; they may be threads, knots or flaps, and spread in all directions. . . . They resemble those which are pushed forward by genuine migrating cells; but in the middle of the substance of the cornea this is only an apparent and not a real prolongation of the protoplasmic body. The retraction of the offshoots is likewise only apparent. If we concentrate our attention to one of the offshoots, we recognize that, by becoming more transparent, it gradually changes its appearance and at last fades away under our very eyes, having assumed the nature of basis substance. The offshoots are not retracted, but become similar to basis substance and thus disappear as well defined formations. The new offshoots have the same origin; they are not pushed forward from the body of the cell, but arise from the basis substance itself. The latter metamorphosis is more difficult to observe than the former; but this can be accomplished the easier the more active the form-changes are."

Last year, J. H. Mennen studied the silver images of the cornea both in its normal and inflamed condition in my laboratory, and has quite recently announced his concurrence in Stricker's view in a paper read before the Brooklyn Medical Microscopical Society, September 4, 1889, and published in the *Brooklyn Medical Journal*, Nov. 1889. He says: "What is already seen in a limited degree in the normal living cornea, is in the inflamed cornea a grand spectacle of a continuous change in the aggregation of the tissue. Basis substance becomes protoplasm, and protoplasm again basis substance, such a change taking place within a few minutes. This is plainly shown in the illustration with a magnifying power of 1000 diameters, the specimen being colored with nitrate of silver."

"It is for the first time that the so-called 'wandering cells' have been successfully fixed by means of this method. A brilliant confirmation of Stricker's assertion indeed! The small light fields are pure protoplasm, remaining untouched by nitrate of silver. From these fields start broad offshoots, which, in their direction and diameter, correspond pretty nearly to the normal conditions. The difference, however, is that these offshoots do not appear light, but light-brown and coarsely granular, owing to the fact that they are just commencing to be transformed into basis substance. In the offshoots the light reticulum is recognized, though perceptibly broader than in the surrounding dark-brown basis substance. In the illustration we see, as far as this can be represented without coloring, all transitions from a light to a dark-brown shading, according as to whether the transformation of protoplasm into basis substance has only just begun or is already completed."

"Since the perfectly light fields are nothing but the fragments of the normal cornea corpuscles and always visible within the original coarse network of the protoplasm, the logical deduction is that we are dealing with, comparatively speaking, a quick transformation of protoplasm into basis substance, and *vice versa* In a freshly inflamed specimen this fluctuation, at the first glance, unquestionably gives the impression of an amœboid locomotion. Stricker rectified the error of all former investigators, and the classification of the cornea corpuscles of von Recklinghausen into 'wandering' and 'fixed' cells must consequently be abandoned."

"In no stage of inflammation of the cornea, where the inflammatory process is located in the centre, does the migration of colorless blood corpuscles, in the sense of Cohnheim, play any part whatever."

Since Dr Mennen has studied under my superintendence, he correctly expresses my own views which entirely corrborate Stricker's assertion. I am fully aware of the revolution that must be the consequence of this assertion in the views held as correct for half a century. First, I have denied the existence of isolated "cells" in the cornea, proving, at the same time, the life of its basis substance. Next I have denied the presence of lymph-channels, demonstrating their identity, as far as size and distribution are concerned, with the protoplasmic tracts. And

now I deny the existence of wandering cells, based upon the fact that both protoplasm and basis substance are alive, and alternately may be transformed into one another under our very eyes.

The hasty assertion of Cohnheim that all inflammatory or pus corpuscles in the cornea are emigrated colorless blood corpuscles or leucocytes, must fall to the ground. All the German and American pathologists, who have accepted Cohnheim's teachings as the standard ones in the doctrine of inflammation, will of course ignore the novel views which completely upset a theory that held sway for nearly twenty-five years. Even their explanation of the silver images in inflamed corneæ, that the isolated leucocytes adapt themselves by an intervening brown line of cement-substance, is proved to be erroneous. J. H. Mennen has shown that these brown lines are dotted, interrupted, owing to the presence of delicate intercommunications between the inflammatory corpuscles. This means that the inflamed cornea, although largely made up of indifferent or medullary corpuscles, remains a tissue nevertheless, and is able to re-enter its normal condition or become transformed into cicatricial tissue. It is only after the breaking of the interconnecting threads that the inflammatory corpuscles become isolated and now represent pus corpuscles. An abscess in the centre of the cornea is, therefore, the result of a disintegration of the tissue, and not an accumulation of leucocytes.

Novel doctrines, deserving a rather acute power of observation, will find approval in a slow way. It is, however, gratifying to learn that in the United States the new views, which are not the worse for having been dubbed "bioplason theory" by my late friend Louis Elsberg, gain ground from year to year. Charles F. Cox, in an excellent presidential address, delivered before the New York Microscopical Society, January 3, 1890, expresses this progress in the following words:

"I can well remember, as perhaps you also can, the disgusted incredulity with which this new doctrine was received,—an incredulity in which, I confess, I then shared. I am not sure that the appearance of a reticulum in the prepared blood-corpuscle is even yet generally accepted as evidence of a normal structure of the kind claimed by Dr Heitzmann; but the claim certainly gains support from the fact that vegetable histologists

are pretty well agreed that a more or less similar reticulum is demonstrable in the protoplasm of plants. Prof Goodale seems to have no doubt on this point, although he thinks that 'this conception of protoplasm as a mass composed of a net-work of minutest fibres enclosing in the meshes another substance, presents . . . great difficulties when we endeavor to explain the movements within the cell,' and that 'it is very difficult to explain in any way the so-called wandering of protoplasm outside the cell-wall or into intercellular spaces.'

"Dr Heitzmann, however, considers the reticulum or mesh an easy explanation of protoplasmic movements. To him the net-work of living, contractile matter contains in its interstices a lifeless liquid, which, by its contraction, it is able to squeeze out of itself, or from one part to another. Thus, he says, 'the liquid held in the meshes, being driven out of the contracted portion, will rush into a portion at the time at rest, and will extend this portion in the shape of what has been termed pseudopodia.'

"In the work from which I have just quoted (Microscopical Morphology, New York, 1883), Dr Heitzmann generalizes as follows: 'What . . . was called a structureless, elementary organism, a 'cell,' I have demonstrated to consist only in part of living matter, while even the minutest granules of this matter are endowed with manifestations of life. The cell of the authors, therefore, is not an elementary, but a rather complicated, organism, of which small detached portions will exhibit amœboid motions. . . How complicated the structure of a minute particle of living matter may be we can hardly imagine; what we do know is that the so-called 'cell' is composed of innumerable particles formerly attributed to the cell-organism.'

"It having been shown that life hangs upon a web of infinite tenuity, and does not reside necessarily in either a vesicle or a lump, it was a natural and easy step to extend this network from tissue to tissue and organ to organ, in an unbroken circuit of vital communication. This step Dr Heitzmann does not hesitate to take, for says he, 'There is no such thing as an isolated, individual cell in the tissues, as all cells prove to be joined throughout the organism, thus rendering the body *in toto* an individual. What was formerly thought to be a cell is, in the present view, a node of a reticulum traversing the tissue. . . The living matter of the tissues exists mainly in the reticular

stage, and is interconnected without interruption throughout the body.'

"Again this at first strange and, for some reason or another unwelcome, doctrine receives support from the investigations of botanists; for, as Prof Goodale remarks, this protoplasmic intercommunication between adjoining cells 'has been shown to be so widely true in the case of the plants hitherto investigated, that the generalization has been ventured on that all the protoplasm throughout the plant is continuous.' The position to which we have traced this matter is, then, to the latest biology, in any particular organism, a generally diffused and interconnected substance, simple only in appearance under present optical aids, has taken the place of the circumscribed, more or less isolated and independent, and recognizably complex vesicle which was the physical basis of life to the science of fifty years ago. In the words of Dr Heitzmann, according to the former view, the body is composed of colonies of Amœbæ; according to the latter, the body is composed of one complete Amœba."

Truth is welcome from whatever quarters it may come. When the learned botanists have grasped my view so clearly, as Prof Goodale has grasped it, there is hope that a majority of animal biologists will also be convinced, sooner or later, of the simplicity and correctness of the novel doctrine. It certainly means one thing—that the cell theory is a fallacy.

EXPLANATION OF PLATE II.

So-called migratory cells from a lamella of a cat's cornea, stained with nitrate of silver; inflammation of twenty-four hours' standing. X 1200.

LL. The so-called migratory cells, unstained lumps of protoplasm within the original protoplasmic tracts.

KK. Broad offshoots of the original protoplasmic tracts.

BB. Dark brown basis substance, pierced by a delicate light reticulum.

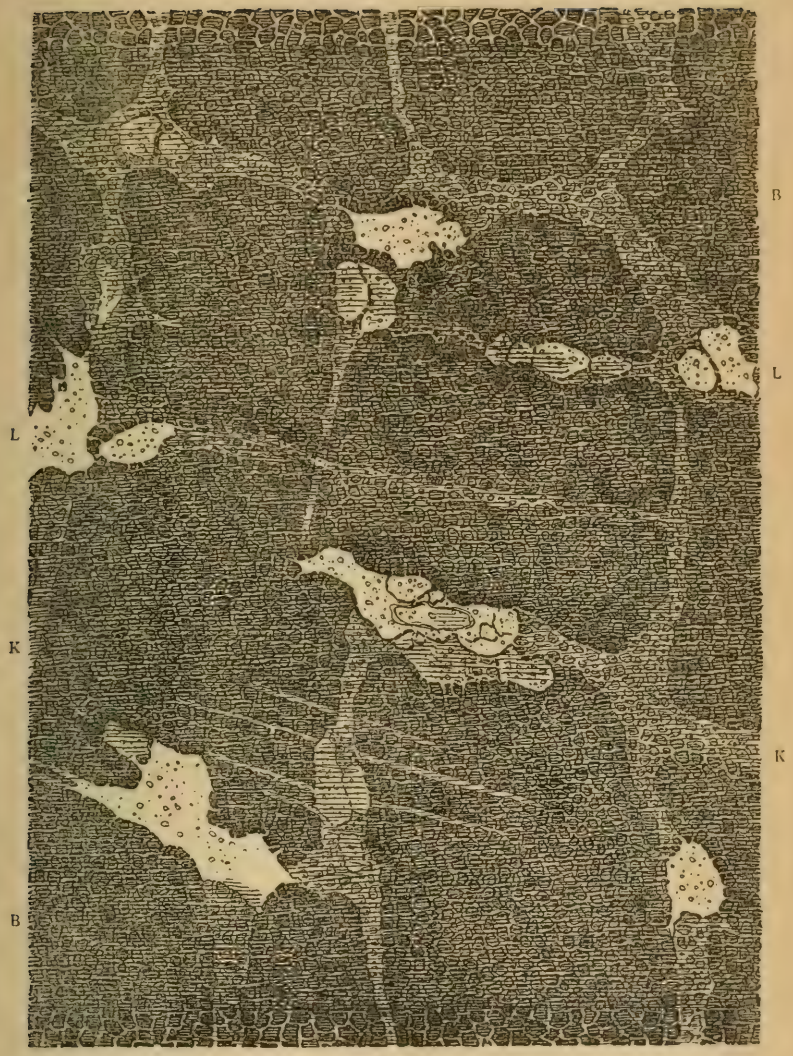
CYTOLOGY OR CELLULAR BIOLOGY.

VII.—CELLS ARE INDIVIDUALITIES—THEY ARE STRUCTURED AND LIVING.

REV A. M. KIRSCH, C. S. C.

AT present, all well informed men, know that the body of organized beings such as plants and animals consists of small parts which, within certain limits, resemble one another. These ultimate components have been called cells—a name, strictly

PLATE II.



speaking, not in harmony with the present state of knowledge; nevertheless it is retained in science, and in fact it would be difficult to replace it owing to its universal use. Professor Sachs in his "Physiology of Plants," Lecture VI., declares that "the true meaning of the word cell may be quite clear to but few, the less so since biologists themselves even now hold and discuss the most different opinions upon it."

According to Canon Carnoy, "Cells are elementary organisms or individualities of organized beings." This view is now very commonly accepted, and indeed cells are now commonly regarded as independent living beings, which sometimes exist by themselves alone, and sometimes are joined with others, millions of them, to constitute a cell-colony or, as Hæckel calls it for plants, "a cell republic." In fact, according to this view the cells constitute the individual somewhat as the zoöids constitute the individual Hydrozoan or the polypi constitute that of the Actinozoan.

Many however, with Sachs, consider cells as only one of the products of the formative forces so universally found in matter, and particularly so in organic substance. In the inorganic substance the highest expression of formative force is the crystal, but not all matter attains to that state although all inorganic matter tends to it, and certainly would reach it if the proper conditions were always and everywhere realized. In the organic world we find the cell as the highest realization of formative force; whether this form is always realized is another question, but it remains nevertheless true that the cell is the organic unit, just as the molecular crystal is the unit of composition in the inorganic world. We are therefore justified in a certain measure in considering cells as elementary organisms or individualities of organized beings. S. Howard Vines expresses this view in the following words. "The body of a plant, like that of an animal, consists of one or more structural units, which are termed 'cells,' and in plants, as in animals, the cell consists essentially of an individualized mass of protoplasm." M. Foster considers cells as only anatomical units, but rejects them as physiological units. Schwann and Schleiden, he says, "considered the properties of the cell, as they described it, as the mechanical outcome of its build," and further on he says, "With this anatomical change of front the physiological cell-theory was utterly de-

stroyed. The cell was no longer a unit of organization, it was merely a limited mass of protoplasm, in which, beyond the presence of a nucleus, there was no visible distinction of parts." To maintain his position, this author selects the *Amœba*, as an example, in order to show that cells are not structured; and whether his arguments are conclusive we leave the reader to judge from his own words. "In its simplest form a living being, as illustrated by some of the forms often spoken of as *Amœbæ*, consists of a mass of substance in which there is no obvious distinction of parts. In the body of such a creature even the highest available powers of the microscope reveal nothing more than a fairly uniform network of material . . . the intervals of the meshwork being filled, now with a fluid, now with a more solid substance or with a finer and more delicate network, and minute particles or granules of variable size . . . Analysis with various staining and other reagents leads to the conclusion that the substance of the network is of a different character from the substance filling up the meshes. Similar analysis shows that at times the bars or films of the network are not homogeneous, but composed of different kinds of stuffs . . ." From this the reader sees that the author contradicts himself. If there is no visible distinction of parts as he at firsts declares, why does he then call attention to the differences in composition and even to the different parts composing the cell of the *Amœba?* Precisely because he cannot get over the idea that the cell is made of different stuffs as he calls it, and that there are parts in it which not only differ in composition but in appearance; in a word, the cell is not a homogenous substance but is composed of parts, in other words, it possesses structure. But in bringing together what is known of the cell it is not my purpose to enter into controversy; I therefore leave the reader free to hold his own opinions.

I will state the thesis of Carnoy in his own words, and follow him as closely as possible in its exposition and demonstration. Prof Carnoy maintains that, "Cells are elementary organisms or individualities of organized beings," and that the cell is "a structured and living mass of protoplasm surrounded by a membrane and containing a nucleus."

THE CELL IS AN INDIVIDUALITY.

By this is meant that every cell is autonomous, that is, it con-

stitutes a whole capable of acting by itself and for itself; it is endowed with an individuality proper to itself. This is not only true for unicellular beings, but also for the cells composing higher beings, provided however that the cells possess the necessary conditions to dispiay their activity, which often requires the concurrence of other cells, of tissues, and even of the whole being.

Closely related to this question is that of cell-fusion. For my purpose however it is sufficient to state that by the fusion of cells the individuality may be lost, but that this is not a necessary consequence. Thus for example, in fertilization the male cell and the female cell fuse so perfectly together, protoplasm with protoplasm and nucleus with nucleus, that the individuality of each cell is lost, and the result is a new individual, the so called cell of segmentation.

In forming a plasmodium, cells that have been free sometimes fuse in great numbers, but this fusion is not so perfect as in the case of the union of the germ cell with the sperm cell; for here protoplasm fuses with protoplasm and nucleus with nucleus, but in the case of a plasmodium the nuclei remain distinct, and the cell has the appearance of being an ordinary multinucleated cell; in this case also, the individuality of each cell has been lost. Examples of the same kind are presented by the Myxomycetes, lactiferous tissue, and particularly in the sporangia of many plants. In many other cases however, the fusion between cells is only at the points where they touch each other, and the cells then do not lose their individuality; they still act for themselves. Cases of this kind are rather common; for example, muscle cells fuse with cells of glands, and nerve cells with cells of muscles.

Frohmann believes that he has been able to trace a connection of the protoplasm through the walls of adjacent cells, and hence some biologists believe in the continuity of protoplasm. If such be the case in any plant, then such a plant may be considered as a variety of plasmodium. Another difficulty we meet in the Cœloblastæ, especially in the genera *Caulerpa*, *Botrydium* and *Vaucheria*. Here we find large and sometimes branching filaments without partition walls. Sachs consider them as simple cells which may be multinucleated, whilst others consider them as cellular filaments in which the partition cell-walls have never

been developed. They may be considered as plasmodia from the beginning or plasmodia by direct formation.

But enough has been said to make the meaning clear. The individualization of protoplasm in the form of a cell is the aim of formative force in the organic world, but whether this typical representation of the life unit is always and in every case realized is a different question. An old adage says, "No rule without exceptions," and this seems to be especially the case in organic nature.

In the second part of the thesis it is stated that a cell is "a structured mass of protoplasm." Here I call the reader's attention to what has been said in the beginning of this paper. Many authorities could be cited for and against this view, and for that matter authorities differ upon almost every important point in science, so that there is at least an apparent reason for the oft expressed opinion that seldom two biologists agree on the same point; but then we have the consolation, that we are not the only class of people to merit this reproach, for it may be applied with equal justice to the philosophers, and I believe these have the honor of priority.

When I say that the cell is a structured mass of protoplasm, etc., I mean that it is endowed with organization, *i. e.*, composed of different parts which are united together in a determined manner, and have different relations with each other. An observer must be blind or his microscope is of the most primitive pattern, if it does not show him that cells are more than a homogeneous, amorphous or crystalline mass similar to inorganic substance. My tube at least shows me in a cell separate elements, arranged according to a well defined pattern. On the outside I notice a membrane, which is more or less distinct, closed, and possessing a certain resistance. Inside of this may be noticed a viscous and apparently hyaline and homogeneous mass, but studded with numerous granules (microsomata): within this substance a peculiar body, the nucleus, which is also limited by a membrane, and within which is also found a hyaline substance, and in this substance are noticed curiously shaped bodies, variable in size for different nuclei. Thus is sketched in a few words the gross anatomy of the cell. But this is only a superficial, and as it were, a macroscopic aspect of the cell structure. Arming the eye with the best of lenses and

examining attentively every part named, we discover details in the structure which are truly wonderful. Good and typical cells, which Leydig already used for observation, may be found in the epithelial lining of the intestines of the little crustacean *Oniscus murarius* (pillbug or wood-louse). This animal is quite common, gathering sometimes in great numbers under boards placed along the foot of a wall.

By magnifying these cells only about 260 diameters, and properly staining them, the protoplasm is seen to be hyaline and transparent, but is far from being homogeneous. In fact, fine threads may be seen radiating from the nucleus towards the cell-wall; these threads send out lateral branches, which unite with others so as to constitute a real network, which is technically called the reticulum. The meshes formed by these interlacing filaments are of various sizes and are filled with a hyaline, minutely granulated substance, which Professor Carnoy first (1883) designated by the name of enchylema.

Between the cells may be seen a shining zone, divided in the middle by a dark line, the primitive membrane, common to juxtaposed cells, as it is the result of cell-division, and at first constitutes only a simple partition between the cells; but subsequently each cell constructs a wall for itself, and this secondary membrane is the white shining lamella seen between the cells.

Next, by focussing upon the membrane of the cell, we may see two things; very minute points, caused, no doubt, by the threads in the membrane crossing each other; these belong to the primitive membrane, and the meshes they form are very minute and hardly visible, but in the secondary membrane the meshes are large and the threads clearly visible. We are therefore lead to the conclusion that the membrane also possesses a reticulum and an enchylema, and is structured.

Finally, within the protoplastic mass may be seen the nucleus, shining like a beautiful pearl. In it may be seen trabeculæ crossing each other, constituting apparently a delicate network. But this is a deception, for if accidentally the needle used in dissection has drawn out a nucleus, we at once see that this is not a real network, but that this filament is really a continuous thread, and that it produced the appearance of a network owing to its convolutions which cross and recross, the result being that

the nucleus has the appearance of containing a beaded network.

Methyl green will stain the filament alone; ammonia and hydrochloric acid will make it disappear, and so reveal the membrane of the nucleus, the nucleoli, the real reticulum of the nucleoplasm with its meshes filled with the nuclear enchylema. Wonderful indeed! Can then the nucleus possess besides this long continuous thread also its own proper reticulum and enchylema? It seems so.

In the following communications I shall describe these structures more minutely; it is here sufficient for my purpose to have arrived at the conclusion that in the epithelial cells of *Oniscus murarius* the three constituting parts of the cell, the membrane, the protoplasm and the nucleus, possess each a similar structure, consisting of a reticulum, the meshes of which are filled with a granular substance or enchylema.

Leydig as before stated, had already observed these cells, but he believed that this structure was peculiar to them alone, but Carnoy proves that this is not an exceptional case; on the contrary, he affirms that this is common to all cells, at least he has found many similarly constructed cells in both kingdoms of Nature.

This structure is especially to be seen during the period of activity of the cell and particularly during the process of cell-division, also during the formation of spermatozoids in the spermatoblast, etc.

But this is not all. Nægeli maintains that the organic bodies, and consequently the cell also has its own molecular constitution. It would require too much space to develop this subject here, but I would refer the reader to Sach's Text-book of Botany for an exposition of Nægeli's theory. In the last part of the thesis, it is stated also that "the cell is a living mass."

By this we mean to say that in the cell, phenomena take place which are peculiar to organic bodies and which are grouped under the comprehensive name of life. These phenomena, although many and various, may be grouped under two headings, viz: simple physical movements, and chemical movements, their object being the nutrition, the growth, and the reproduction or multiplication of the cell.

In subsequent papers, I shall treat this question more fully, but here I wish to state that the protoplasm is not alone con-

cerned in this activity, but that the membrane and nucleus also participate in the life activity of the cell. The entire cell is therefore living. To it we must ultimately descend to seize life in its source, and here we may study the phenomena of life in their simplest expression.

If it is ever alloted to mortal man here below to arrive at any knowledge of life, it is clear that a complete and profound knowledge of Cytology will be the key to the mysteries of that now unknown region.

DIATOMS AND ETYMOLOGY.

CHARLES S. BOYER.

THE writer, who is somewhat of a diatomaniac, has been very much puzzled over the written description of Diatoms. In the course of his investigations, he had occasion to start *ab ovo*, and to inquire what must have been the impressions of those who first named each genus, and he was surprised to find that the name, in nearly every case, suited the Diatoms perfectly, and that if the matter had ended there, the determination of many forms would have been less difficult.

We would, therefore, advise the young investigator to provide himself with a Greek lexicon and start out at once on his discoveries. Ever so many Diatoms are called plates, with words prefixed to distinguished the different kinds of plates. Thus, if the diatomaniac discovers a glass plate, he knows that he has a *Hyalodiscus;* if a plate looking like a sieve a *Coscinodiscus;* a plate that is bent, a *Campylodiscus;* a plate with grooves or furrows, an *Aulacodiscus;* a plate that looks exactly like a spider's web, an *Arachnodiscus;* a plate that has projections looking like towers, a *Pyrgodiscus;* a plate with hollows, a *Glyphodiscus;* a plate looking as if it had been punctured or pricked, a *Stictodiscus;* a plate with scales. a *Lepidodiscus;* and a plate with foot-like processes, a *Eupodiscus.* But it is not necessary to confine ourselves to plates of Diatoms, which are sometimes deceptive.

It will not be difficult to find litttle bowls or boats in *Cymbellæ*; nails or pegs in *Gomphonemæ;* syringes with curious roots in *Rhizosolenia;* a trident in *Trinacria;* and various kinds of boxes, from a little box, *Pyxilla*, to a box with corners, *Goniothecium*, and a box with a crown, *Stephanopyxis.* If we are particular to look at

the marks on our specimens, we may readily discover that one bearing written characters must be a *Grammatophora*, and of course, we recognize a letter in the S-shaped *Pleurosigma;* and that one with bands across it, like a ladder, must be a *Climacosphænia*. If the bands give a wavy appearance to the sides, it must be a *Cymatopleura*.

Then there are some that look like wands, as in *Bacillaria*, and a *Bacteriastrum*, of course, is a *stick* bearing stars or rays. The horny hairs of the *Chætoceros*, and the tubes of the *Auliscus* distinguish them at once. If we want a buckle, we have one in *Porpeia*; a *little* boat in *Navicula;* a sun-shield in *Heliopelta;* a shield with a boss in *Omphalopelta;* a little strap in *Himantidium;* a melon in *Peponia*, and a very ancient water-bottle with a narrow neck in *Isthmia*.

If we notice flower-like forms in the sea foam, we recognize *Achnanthes*, and that which resembles a "fan-shaped basket borne upon the head in the feasts of Bacchus," is a *Licmophora*. In the *Triceratium* we do not always find three horns, but we discover a single eye in *Monopsia*, a cross in *Stauroneis*, a bow in *Toxonidea*, rods in *Rhabdonema*, an angular breast in *Mastogonia*, and, possibly, a sea-urchin in *Spatangydium*.

Schizonema, with tubes or threads massed into leafy or split forms; *Encyonema*, with its pregnant tubes, and *Colletonema*, with tubes or threads glued together, showing, as Van Heurck remarks, a transition between the preceding and *Navicula*, are good subjects for controversy as to classification. We must not omit the sociable *Syndræ*, found sitting side by side in council.

Our lexicon will not aid us in following *Nitzschia*, *Biddulphia*, *Brightwellia*, *Donkinia* and many others, nor would a biographical dictionary be of any better service in the identification of forms. They must be left to commemorate the services of Nitzsch, of Brightwell, of Donkin and other diatomists. *Biddulphia* is said to have been named after a Miss Biddulph, of England.

When we come to the determination of species, we must, of course, change our Greek for a Latin lexicon, and while it may seem startling to translate *Coscinodiscus Oculus-Iridis* as an "Iris-eyed sieve plate," a glance at it under the microscope will scarcely suggest a better name. From this short diversion, it appears that the nomenclature of diatoms has been in worthy hands, and has not suffered from much of the incongruity found in other branches of botanical science.

THE DIOPTRICAL PRINCIPLES OF THE MICROSCOPE.

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FOR calculating the path of light through a centred system of lenses (omitting spherical and chromatic aberrations), the formulæ hitherto used are unnecessarily complex. I have tried an easy formula given in *Matthiessen's Dioptrik*, and find that it can be extened to all cases, so that a single formula, easily obtained and easily remembered, can be used to determine the focal lengths of lenses, doublets, objectives and of the entire optical system of a microscope or telescope, and a slight variation of it enables us to find the principal planes of lenses real and imaginary. Thus we can understand our favorite optical instrument without using the troublesome algorithm of continued fractions given by Gauss.

The method may be best illustrated by indicating its application to the problem of an objective given in *Nägeli* and *Schwendener's* book on "*The Microscope.*" It is required to find the focal lengths of an imaginary lens equivalent to an objective consisting of three doublets, each doublet being a plano-concave flint-glass lens backed by an equiconvex crown-glass lens, the refractive indices of flint, crown-glass and air being given.

I. For the *surface refractions.* The refraction of a ray through a surface from medium with index n_0 to another with index n_1, produces two focal lengths, a first focal length, f_1, for rays entering medium n_0, and a second g_1, for rays entering medium n_1; and the general equation is

$$f_1 = \frac{\frac{n_0\, r}{n_1}}{\frac{n_0}{n_1} - 1}; \qquad g_1 = \frac{\frac{n_1\, r}{n_0}}{\frac{n_1}{n_0} - 1}$$

whereby, making r positive for rays approaching a convex surface, and negative otherwise, we can find the surface refractions. For the flat face of the flint lens we use the two values $f = -\infty$, $g = n \times \infty$, as the ratio of the two values is required.

II. *For the Lenses.* Having got the surface refractions (f_1, g_1, for the first surface refraction, and f_2, g_2 for the second) we apply

our general formula to find the character of the lens as a whole. The formula is $f = \frac{f_1 f_2}{f_2 - g_1 + t_l}$ where f is the required principal focal length of the lens, t_l is the thickness of the lens, and the other terms are as already explained. The second focal length of the lens, g, is equal to f with the sign changed, when the same medium is on both sides, but may be got separately by the formula

$$g = \frac{-g_1 g_2}{f_2 - g_1 + t_l}$$

These focal lengths are to be measured from the principal planes, f from the first plane, g from the second plane of the real or imaginary lens. I propose to designate the three segments depending on the principal planes, by the names *anteplane*, *interplane*, *postplane*, and the interval between the second principal plane of one lens and the first principal plane of the following lens (real or imaginary) by the term *transit* (indicating it in the formula by t, as in combining two lenses it has the same function as *thickness* t_l has in one).

The formulæ for determining the anteplanes and postplanes, and thereby determining the principal planes are

$$a_1 \text{ (anteplane)} = \frac{-f_1 t}{f_2 - g_1 + t};$$

$$a_2 \text{ (postplane)} = \frac{-g_2 t}{f_2 - g_1 + t}$$

(where t is either thickness or *transit* in different cases. It may be marked as t^c, thickness of crown-glass lens, t^d transit of doublet, t^o transit of objective.)

It will be observed that all the formulæ have the same form of denominator.

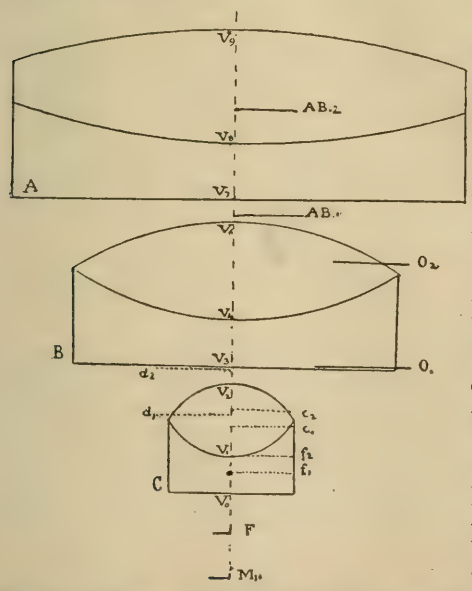
In all cases conjugate focal lengths (j_1 and j_2) can be got from each other and the principal focal lengths by the equation

$$\frac{f}{j_1} + \frac{g}{j_2} = 1.$$

III. *For the Doublets.* The imaginary lens that is equivalent

to a doublet has the first principal plane of the first lens as its face and the second principal plane of the second lens as its back, whilst its thickness is represented by the transit-distance between the second principal plane of the first, and the first plane of the second lens. Otherwise we employ the same formulæ as before for combining the focal lengths of the component lenses so as to get the focal lengths and principal planes and position of the equivalent lens.

IV. Having determined the Doublets, we use the same formulæ for *combining them into the Objective*. I have thus followed *Nägeli and Schwendener's* problem by combining the second and third doublet to get a low-power objective, and by combining this with the front doublet, to get a high-power objective. The results reached are same as by their method (saving a trifling arithmetical error in one of their calculations); but these results are reached in a much simpler and more intelligible way than the one which they follow. By combining the lenses of the eyepiece together, and finally the eyepiece and objective, every step only a repetition of previous steps, we come to find the dimensions and focal length of an imaginary lens equal to the microscope or telescope.



V. Example. — The example to be worked is a microscope having an Objective consisting of three doublets and the ordinary Huyghenian eyepiece. The Objective has its doublets, C, B, A, composed each of a plano-concave flint-glass lens backed by an equally-convex crown-glass lens; the flint-glass having 1.6, and the crown-glass 1.5 as refractive index. The first doublet has flint-glass lens $\frac{1}{2}$ millime-

tre thick, crown-glass lens 1 millimetre thick, radius of curvature 1; second doublet $\frac{2}{3}$ and $\frac{1}{3}$ thick, and radius 4; third doublet $\frac{2}{4}$ and $\frac{2}{2}$ thick, and radius 10. The front vertex of the second and third doublets coincides in each case with the second principal plane of the underlying doublet. Our figure is drawn to scale, multiplied by 10 lineally, and the surrounding medium is assumed to be the air, having its refractive index $n_o = 1$.

First doublet.—The front surface of its *flint-glass lens* being flat has the principal foci at infinity, being to each other however 1 to n. Its 2d surface has by the formulæ (where $n = 1.6$, and $r = -1$)

$$f_2 = \frac{nr}{n-1} = \frac{1.6}{.6} = \frac{8}{3}, \quad g_2 = -\frac{r}{n-1} = -\frac{1}{.6} = -\frac{5}{3}.$$

For the lens as a whole, the first principal focal length

$$f = \frac{f_1 f_2}{f_2 - g_1 + t} = \frac{\infty \frac{8}{3}}{\frac{8}{3} + n \infty + \frac{1}{2}}$$

Here the first and last terms of the denominator disappear relatively to the infinity of the central term.

Thus $f = \frac{\frac{8}{3}\infty}{n\infty} = \frac{\frac{8}{3}}{1.6} = \frac{5}{3}$

Also the second focal length $g = -f = -\frac{5}{3}$.

Anteplane, $a_1 = \frac{f_1 t}{f_2 g_1 + t} = \frac{f_1 t}{g_1} = \frac{t}{n} = \frac{\frac{1}{2}}{n.6} = \frac{5}{16}$.

Postplane, $a_2 = \frac{g_2 t}{f_2 g_1 + t} = \frac{g_2 t}{\infty} = 0$

Thus the 1st principal plane (f_1 in the figure) is $\frac{5}{16}$ above the vertex V_o, and the 2d principal plane (f_2) coincides with the back vertex (V_1) of the flint-glass lens.

Its crown-glass lens gives for its principal focal lengths (f_1 g) (having $n = 1.5$, and $r = 1$ for its front curve, and $= -1$ for its back curve), first surface, $f_1 = -\frac{r}{n-1} = -\frac{1}{1.5-1} = -2$; $g_1 = \frac{nr}{n-1}$

$= \frac{1.5}{1.5-1} = 3$; second surface, $f_2 = \frac{nr}{n-1} = -3$; $g_2 = \frac{r}{n-1} = 2.$

Lens as a whole: 1st focus, $f = \frac{f_1 f_2}{f_2 - g_1 + t}$, $f = \frac{-2 + -3}{-3-3+1} = -\frac{6}{5}$;

g (2d principal focus) $= -f = \frac{6}{5}$.

Anteplane $= \frac{f_1 t}{f_2 - g_1 + t} = -\frac{2\times 1}{-3-3+1} = \frac{2}{5}$; Postplane $= \frac{g_2 t}{f_2 - g_1 + t} = -\frac{2}{5}$.

Thus its first principal plane (c_1 of the figure) is $\frac{2}{5}$ above its front vertex, V_1; and its second principal plane, c_2, is $\frac{2}{5}$ below its back vertex V_2, the minus sign indicating that it is to be measured downwards. For the doublet as a whole (using sub-script letters f and c to mark the parts of the flint and crown-glass lenses already found); we have for the first transit (which represents the thickness of the imaginary equivalent lens) the distance $f_2 - c_1$, between the back principal plane of the front lens doublet, and the front principal plane the back lens; this distance $f_2 - c_1 = \frac{2}{5}$.

Hence for the first principal focal length of the doublet,

$$f = \frac{f_c f_f}{f_c - g_f + t} = \frac{\frac{5}{3}\times(-\frac{6}{5})}{-\frac{6}{5}-(-\frac{5}{3})+\frac{2}{5}} = -\frac{30}{13}$$

Second principal focal length, $g, = -f = \frac{30}{13}$.

Ante-plane of doublet $= \frac{f_f t}{f_c - g_f + t} = \frac{\frac{5}{3}\times\frac{2}{5}}{-\frac{6}{5}-(-\frac{5}{3})+\frac{2}{5}} = \frac{10}{13}$.

Post-plane of doublet $= \frac{g_c t}{f_c - g + t} = \frac{\frac{6}{5}\times\frac{2}{5}}{-\frac{6}{5}+\frac{5}{3}+\frac{2}{5}} = \frac{36}{65}$.

This signifies that the 1st principal plane of the doublet is $\frac{10}{13}$ above the first principal plane of its front lens (above f_1 in the figure), and that its 2d principal plane is $\frac{36}{65}$ above the 2d princi

plane, c_2, of the back lens; we say *above* because both are positive. We have accordingly marked d_1, d_2 at these distances, as the principal planes of the doublet. It will be observed that the second of these planes is some distance external to the lens; yet the second focal length of the doublet ($g = \frac{23}{11}$) should be measured upwards from this plane, and would, in fact, be found above the point V_7.

2.—By the same method we measure the mid-doublet B, and again the back-doublet *A*. Thus we find the *transit* for the two doublets *A* and *B*, or the distance between the upper principal plane of the lower, and the lower principal plane of the upper doublet; this turns out to be 1.4977. The formulæ already used now enable us to combine these two doublets into a low-power Objective, whose two principal planes are found to lie at the lines A $B._1$, and A $B._2$ of the figure, and whose focal length is 2.1305, measured from these planes.

Our next step is to combine the low-power objective with the front doublet, having as the transit distance (d_2 to *A B*, in the figure), 2.00428. The principal planes of the objective are found to be at O_1 and O_2 of the figure, and its focal length is 2.2162.

3.—The eyepiece consists of two convex-plane lenses of crown-glass, convex-side downwards; the lower is 3 thick, and of radius of curvature 40; the upper is 2 thick, and of radius 30; the space between them is 43. By the method already pursued we combine these lenses to an equivalent of the eyepiece, getting as focal length 48, as anteplane 72, postplane 54. Hence the first principal plane is 72 above the lower principal plane of the lower or field lens; and this measurement carries it 24 millimetres, or nearly an inch, above the eyepiece; whilst on the other hand the second principal plane being negative is to be measured downwards from the upper principal plane of the eye-lens, and is $7\frac{1}{3}$ below the lowest face of the eyepiece. Thus the principal planes are inverted in the eyepiece, the first one becoming uppermost.

4.—Combining the eyepiece with the objective, we use as our transit, the whole distance between the upper principal plane of the objective and the first principal plane of the eyepiece. This distance depends chiefly on the microscope tube, and on the con-[illegible]ition of the draw-tube. In the short microscope which I am [illegible]amining, this transit was found to be 220.8432, and the for-

mulæ gave as focal length of the whole microscope .623, while the lower principal plane was found to be 1.18 below the front vertex (at M_1 in the figure, that distance below V_o), while the upper principal plane was found at 6.794 *above* the eyepiece. The anterior focal length is positive, being measured upwards from M_1, and its focus is represented at F. The focal points are thus nearer than the principal planes; this indicates that it is a virtual focus, and that the image seen in the compound microscope is a virtual image. The object when viewed through the microscope should be somewhat nearer to the vertex V_o than is the principal focus F; it is to be at the conjugate point, depending on the distance of the other focus above the eyepiece. By the term "one-inch objective" is signified, not the actual distance of an object in focus from any part of the combination, but the principal focal distance when measured from the proper principal plane of an equivalent imaginary lens. In the example before us the whole microscope is found to be the equivalent of a single imaginary lens of .623 focal length which, according the conventional distance of natural vision, 10 inches or 263 millimetres, will represent a magnifying power of 406.

For both telescope and microscope, the ultimate principal planes are found to be external to the instrument, one in the air in front of the object-glass, and the other somewhere in the eyeball of the observer; this can do injury, however, as these planes have no actual existence, but are mere devices to facilitate our calculations.

THERE is already a vast variety of microscope stands in the market, but another is needed. The ingenious optician that shall first supply it will have a merited reward. A travelling stand is needed; one that the owner can travel with, and one that can travel with the owner.

In this department, some suggestions have been made as to the advisability of taking the microscope on the summer vaca-

tion. This desirability is conceded. But at once there arises an obstacle; in fact there are three of these obnoxious things. The ordinary instrument is usually too large and heavy to be taken, and for this reason is often perforce left at home. There is no entirely commendable travelling stand in the American market. Some of our opticians should make one at a reasonable cost, if such a thing is possible. Mr Zentmayer's Pocket Stand is magnificent; it is perfect, but its perfection puts it beyond the reach of any but the wealthy microscopists, of whom there are few. Mr Zentmayer has a Portable Histological stand, but aside from the cost, it is too large for the present purpose.

The ideal instrument will be light in weight, a thing not incompatible with steadiness and stability. The body tube will be large enough to receive the largest eye-piece made by any reputable optician in the world. It will be sold without oculars, so that the purchaser of this summer instrument can use his own eye-pieces. If they shall be too small to fit properly, any one can bandage them with a strip of paper and a little mucilage, making a cylinder that when dry will be almost as hard and firm as a wooden one. The body at that end will thus be adapted to all ordinary demands. At the other there will be the society screw. This goes without saying. The coarse adjustment should be by rack and pinion; if necessary to save expense and weight, the milled head on the left hand side may be omitted. The fine adjustment should be at the back of the arm, and no graduations would be needed on any part, as vacation work will not deal with the measurement of thin glass, the working distance of high power objectives, the angles of crystals or of aperture. The vacation microscopist will be seeking recreation and amusement, the one for himself, the latter for his friends at the shore and among the mountains. There must of course be a joint for inclination, as the microscopist is now struggling with a weary back, and will not care to own anything so burdensome as an invertebrate stand.

As the ideal travelling stand will be portable with its case, it might dispense with a special foot and be screwed into the top of its box, as Mr Zentmayer's Pocket Stand is arranged. This would increase the lightness and decrease the cost.

The stage should be of the simplest form. It needs only spring clips to hold the slide in position. But will the maker

please fasten them immovably? The microscopist is now on his vacation, and he is tired by the year's work; he does not care to add to the weariness of his fingers by continually pushing the clips back into place; neither does he want them to glide around slowly and then with a screech of fiendish glee snatch off the cover glass and crunch it up. He is in the quiet woods or by the murmuring sea, and in neither place does he want to frighten the birds or the fishes by saying bad words. So please fasten those clips; and do not make them needlessly stiff.

A simple disk diaphragm will be needed, but it should be so arranged that it can be entirely removed, as this ideal stand will have a substage ring to receive the condenser. This ring should be so large that it will take any modification of the Abbe condenser in the market, an adapter being the portion of any that shall not properly fit. See that the ring is large enough, and also that it is so attached that it can focus the condenser by being slid into position by the fingers.

The concave and plane mirrors will be so arranged and mounted that the whole may be removed and placed in the proper position on the upper surface of the stage to illuminate opaque objects. Its curvature should therefore be such that it will be focussed on the object when it is attached to the stage.

That is all. The ideal travelling stand, therefore, is only a kind of skeleton affair without eye-pieces and without objectives, because the purchaser will have these on his larger home instrument. It will be as simple and as cheap as is possible with good workmanship and good service.

The optician that undertakes to make such a desirable stand must not forget that his success will depend entirely on the cost of the instrument. The microscopist already has a microscope. It is too large and cumbersome to be taken with him on his summer vacation. Although he may possess a continental instrument, smuggled into the country through some accommodating college, he will find it too heavy to be packed in his trunk or his satchel. In the trunk it may wabble about and damage the bonnets and the—that is to say, the continual jarring may injure it. In his own satchel it soon becomes too weighty to be endured. The continental stand will not answer the purpose. Mr Zentmayer's Pocket Stand is well named, for it is light enough to be easily borne in the pocket where I have seen it carried. The

price is the point to be considered by the maker. If he can show that the microscopist can afford to have a travelling as well as a home instrument, the price must be attractively small. He need conjure up no arguments as to the advisability of taking the microscope on the vacation. We all concede that point. We all feel that we lose when compelled to leave the microscope behind us, but it is usually impossible to do anything else under the present condition of microscopical affairs.

Since I am giving the manufacturing opticians "points," let me add another. When this ideal travelling stand is ready, if there are any microscopists that do not care or are unable to buy it, would there be any objection to the renting of it? The opticians are bright enough to devise some scheme to assure the microscopist that the optical establishment will still be in existence at the old stand when the summer vacation is over, and the microscopist comes home ready to buckle down to work once more. In this way the optician would in time sell his stands and have them too. It is a solution to the problem of eating the cake and having it.

The writer is not a manufacturing optician. There may be some features in this ideal travelling stand that will cause the practical manufacturer to faint with laughter. Very well. But when you recover your senses, get to work on the stand and have it ready for the next summer's holiday. But remember, if you please, the three essential requirments: 1, Lightness: 2, simplicity: 3, Cheapness.

ACKNOWLEDGMENT.—To Dr D. B. Ward for photo-micrographs of Diatoms.

NEWS · FROM · THE · WORKERS ·

THE ANTWERP INTERNATIONAL EXPOSITION ORGANISED UNDER THE AUSPICES OF THE COMMUNAL ADMINISTRATION OF THE PROVINCE, ON THE OCCASION OF THE 300TH ANNIVERSARY OF THE INVENTION OF THE MICROSCOPE.

PROGRAMME OF THE EXPOSITION OF GENERAL AND RETROSPECTIVE MICROSCOPY.

Class I.—Microscopes for all current researches.—A.—Microscopes with mechanical stage and sub-stage.—Models with English [long] and continental body tube.—Ordinary microscopes for general researches.—Cheap microscopes for elementary studies. —B.—Special microscopes.—Binoculars, minerological, petrographical and similar microscopes.—Microscopes for photography.—Reversed, travelling, pocket and class microscopes.—Microscopes with two or more bodies.—Microscopes for museums, the stage carrying numerous objects, etc.—Projection microscopes.—Objectives and eye-pieces. Achromatic and apochromatic objectives. Dry, water, homogeneous objectives, etc. —Eye-pieces: Huyghenian, Ramsden, orthoscopic, compensating, projection, etc.—Apparatus for illumination. Achromatic and non-achromatic condensers.

Class II.—Illuminating apparatus. Petroleum and gas lamps; apparatus for oxyhydrogen light; apparatus for arc and incandescent electric lighting; special electric piles.

Class III.—Photomicrographic apparatus. Special microscopes. —Various cameras.—Photomicrographs.

Class IV.—Various apparatus. Binocular apparatus adjustable to any microscope.—Rotators.—Adapters. Micro-spectroscopes. —Polarising apparatus.—Camera lucidas for the microscope vertical, inclined and horizontal.—Goniometers.—Hæmatimeters.—Chromometers.—Growing cells.—Compressors.—Moving stages.—Erectors.—Binocular and stereoscopic eye-pieces.—Abbe diffrac-

tion plate.—Apparatus for warming the object under the microscope.—Various apparatus not mentioned.

Class V.—Apparatus for measuring. For the eye-piece, for the stage, for the cover glass.

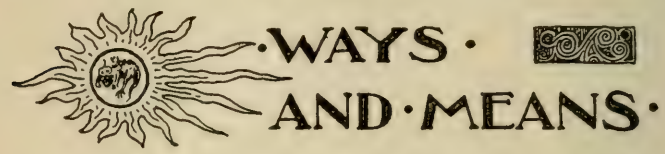
Class VI.—Micrometers. Hand and mechanical micrometers. —Apparatus for ruling micrometers and Nobert's lines.

Class VII.—Apparatus and accessories for microscopical preparations and dissections. Simple microscopes, doublets, magnifying glasses.

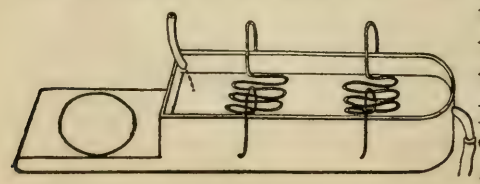
Class VIII.—Microscopical preparations. Preparations of all kinds. Simple and systematic preparations. Type plates and test plates.

Class IX.—Apparatus for bacteriology. Culture ovens; ovens with low and constant temperature; ovens for sterilising by dry air and by vapour.—Apparatus for the coagulation of blood.—Apparatus for the sterilisation of serum.—Boxes for disinfecting instruments and for sterilising gelatine plates.—Regulators of gas pressure.—Inextinguishable lamps and lamps that automatically lock when the flame is extinguished.—Apparatus for the seeking of microbes in the air and water.—Glassware for bacteriology (flasks, tubes, blocks, plates, warm water funnels, hooks, etc.).

Class X.—Works on the microscope. Treatises on microscopy. Works treating of all the applications of the microscope.



A FISH TROUGH.—An object which always interests the microscopist, and excites the wonder and admiration of those who regard things microscopic from the point of popular interest, is the circulating blood in living creatures. Nothing in this line has proved more satisfactory than the microscopic view of the circulation in the tail of the gold fish. Thanks to Mr. Kent's invention of the fish trough, the arrangement of the fish for this purpose has been rendered comparatively simple and easy.



The trough consists of a metallic vessel provided with a thin extension at one end near the bottom furnished with glass-covered apertures above and below. The body of the fish between the gills and tail is wrapped with a strip of soft cloth, and the trough being filled with water, the fish is placed therein, with its tail projecting into the extension between the glass covers. The tank is arranged on the microscope stage with the tail of the fish in position for examination. So long as the fish remains quiescent, all goes well, and the beautiful phenomenon may be witnessed with great satisfaction, but the subject soon becomes impatient, and at the most inopportune moment either withdraws its tail from the field or jumps out of the tank, thus causing a delay which is sometimes embarrassing.

The uneasiness of the fish is caused partly by its unnatural position, and partly by the vitiation of the water. The latter trouble has been remedied by the writer, by inserting a discharge spout in one end of the trough, and providing a tube for continually supplying fresh water. The other difficulty has been surmounted by providing two wire grids, each having spring clips at their ends for clamping the walls of the tank. These grids are pushed downward near the body and head of the fish, so as to confine the little prisoner closely without doing it the least injury. With these two improvements the examination may be carried on comfortably for an hour or more.—*Geo. M. Hopkins in Sci. Am.*

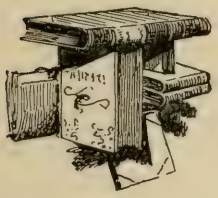
A GOOD CEMENT.—An article in the May number of THE MICROSCOPE prompts me to suggest a trial of a cement that I have found useful.

Gelatine dissolved in a 10 per cent. solution of potassium bichromate. The solution should be kept in the dark and be just thick enough to run easily from the brush. Wipe off the surplus glycerine, and spin on a ring of the bichromate gelatine and expose to the sunlight. It soon hardens to an insoluble, horny substance. A second ring of the same may be spun on in a day or two, and afterward the mount may be finished with any other cement or lacquer.

I do not suppose that I am the first or only person who thought of this, but I do not remember seeing it recommended

for this purpose. I got the idea from the use of bichromated gelatine in photo mechanical processes.

GEO. E. BLACKHAM, M. D.



NEW PUBLICATIONS

THE SOUL OF MAN, an Investigation of the facts of Physiological and Experimental Psychology. Dr Paul Carus. Chicago: The Open Court Pub. Co. 12mo, pp. 480. Price $3.00—The author's object is to collect, as he says, all the facts of the Psychologies, Physiologies and Anatomies bearing upon the incidents of experimental Psychology. Up to this time there has been no single volume embodying these observations, and treating the problem of the human soul scientifically in its philosophical, ethical and religious importance. This unoccupied niche the book is intended to fill. To say that it is as "readable as a novel" is giving it scant praise. It is of absorbing interest, and to the thoughtful will be a most valuable acquisition. Its statements are made in an attractive form, with illustrations and diagrams to explain and to emphasize. The work is eminently meritorious, although the reader will not rarely find cause for disagreement with the author, who takes his position with a boldness and energy that are refreshing, whether his teachings are accepted or not. The work may be commended for its compiling and condensing of scattered material, if for no other reason, yet there are many other reasons for giving it an attentive hearing.

DOMESTIC SCIENCE. A Book for Use in Schools and for general Reading. Dr J. E. Talmage. 16mo., pp. 331. Salt Lake City: The Juvenile Instructor Office.—This book more than attains its object, which is to bring together such topics as have a direct bearing upon the science of domestic operations and upon daily household affairs, since it includes many matters not very closely connected with these subjects. It is written in a simple and pleasing style while the experiments described and illustrated are easily performed, usually with home-made apparatus. The

author treats of air and ventilation, heating and lighting; of water, its functions and properties; of food and its cooking; of cleansing agents, and of poisons with their antidotes. But while the book is laudable, it contains some errors that should not have been overlooked. On page 149 it says that Agassiz found that the body of "an aurelia or sun-fish alive weighed 30 lbs., yet when dried yielded but half an ounce of solid matter." This is somewhat of a libel on the animal; substitute jelly-fish and the statement will be correct. The index is sadly in need of revising and of rearranging.

PROCEEDINGS OF THE AMERICAN SOCIETY OF MICROSCOPISTS. Vol. XII. Price $2.00. C. C. Mellor, Pittsburg, Pa.—The annual volumes published by the society have steadily increased in scientific value and interest, from the first, now thirteen years old, to the present issue which is the superior of all its predecessors. If the improvement shall continue to be as constant and as even, the society will soon take a position of equality beside any similar association anywhere. The present volume contains much of value, and should be welcomed by all microscopists, whether they are members of the society or not. The general index brings the preceding volumes within very convenient consulting distance.

EDITOR THE MICROSCOPE:—

In your April number is an article that mentions a good way to make a reagent bottle, which if a person's time was of no account would involve considerable skill to make, especially as an article is already better made for four cents by the S. H. Wetmore Co., 242 Pearl St., New York.

This firm has a dropping tube combining a soft rubber bulb and a cork in one piece; the glass points are of two sizes and

either straight or curved, the smallest, called an eye dropper, delivering about one fourth of a minim; the larger is a medicine dropper and delivers one minim at a drop; they fit into a one or two ounce bottle, and as they hang straight in it are never clogged at the point and can be reinserted in the vial after each using easier than a common reagent tube can be laid down. They are cheap, always ready and, fitting tightly, keep out dust and prevent evaporation.

The making of cells involves considerable trouble and time to those who only occasionally use the microscope; why are there no slides on sale that have the cell ground in the glass? We have slides with a concave cell ground in them, why not have cells with their sides perpendicular to the base? It does not seem as though it would be very much of a mechanical triumph to do so, when this bother of cell making would be banished. Machinery should make cells of all sizes and depths cheaper than the hand.

BOULDER, COL. CHAS. AMBROOK, M. D.

EDITOR THE MICROSCOPE:—

Respecting the "polarizing with one Nicol," there is something better, at all events easier than the use of the sky, and that is any glazed surface, except of metals (even a dish of water will do very well), all of which can polarize the light; the darker the color the better. In order to make use of it, merely turn aside the mirror and take the "sheen" from your mahogany table, for instance. Daylight is sufficient, although sunlight gives more brilliant effects. This is not original with me, but will be found in many text books of physics.

PHILADELPHIA. HANS M. WILDER.

EDITOR THE MICROSCOPE:—

A short time ago I ordered of Prof M. D. Ewell, of Chicago, a stage micrometer ruled 1, $\frac{1}{10}$ and $\frac{1}{100}$ mm.

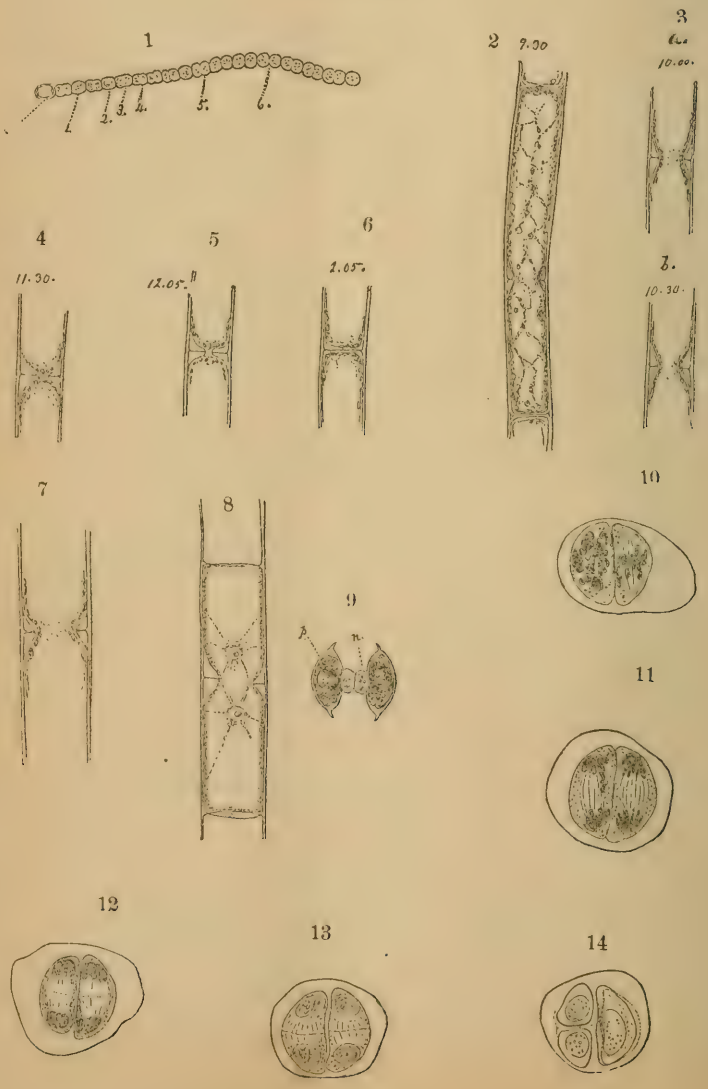
I submitted this micrometer to a most thorough examination, examining and re-examining line for line for the purpose of determining any possible variation in the rulings.

The variation in the width of the spaces is too small to estimate; the error therefore is an insensible one.

A Spencer $\frac{1}{10}$ H. I. objective was used for testing this slide, which I consider a most excellent micrometer.

BUFFALO, N. Y. JOHN A. MILLER. PH. D.

PLATE III.



THE MICROSCOPE
AN ILLUSTRATED MONTHLY MAGAZINE.

VOL. XI. TRENTON, N. J., AUGUST, 1891. No. 8.

ORIGINAL COMMUNICATIONS

CELL-DIVISION IN PLANTS.

PROFESSOR DOUGLAS HOUGHTON CAMPBELL, PH. D.

PLATE III.

AS botanists concern themselves more and more with the biological aspects of the science, the problems connected with the structure and multiplication of the plant-cell are assuming great importance, and it may interest the readers of THE MICROSCOPE to have in brief form some of the results of the later investigations on the subject.

Strasburger has probably done more than anyone else to advance our knowledge of the plant-cells, and to him we owe very much in regard to the minute structure of the cell, and the processes of cell-division.

The complete plant-cell, as is well-known, consists essentially of three parts, viz., cell-wall, protoplasm and nucleus. Besides these, other structures may be present such as the plastids, of which the chloroplasts or chlorophyll-bodies are the most familiar. These plastids are now known to be, when present, essential parts of the cell, and are always formed by division of pre-existing bodies of like nature, and never arise from undifferentiated protoplasm.

Usually most cells contain one or more vacuoles filled with watery cell-sap. The Dutch botanist De Vries, and his pupil Went, claim to have proved that these also can be traced back to the youngest cells, and like the plastids arise by division of preexisting structures like themselves. This however, is not admitted by all botanists, and requires further investigation before it can be accepted without question.

In most plants the cells are provided with a distinct cellulose membrane and are clearly separated from one another. Each is provided with a single nucleus and when the cell divides this is accompanied by a corresponding division of the nucleus.

Sometimes however, we find that the division of the plant-body into distinct cells is incomplete, and that the nucleus may divide without any division of the protoplasmic body of the cell; and this process may be repeated until a large multi-nucleate cell results. If, therefore, we regard a cell, in its strict morphological sense, to be a mass of protoplasm with a single nucleus, these large "cells," are not properly to be regarded as such. Common instances of these multi-nucleate cells we see in the various Algæ known as *Siphoneæ*, of which various species of *Vaucheria* are common examples. Similar structures are the hyphæ of most fungi.

In the lowest plants it is still an open question whether a nucleus, in the proper sense of the word, can be said to exist, although there is little doubt that nuclear substance is present in all of them. Of these low plants the bacteria and the Algæ known as *Cyanophyceæ* are familiar to all students of the lower plants. To the latter group belong many familiar forms, among them the different species of *Nostoc*, one of which is shown in figure 1.

Here we have an instance of cell-division in its simplest form. A single filament of the plant will usually show all stages in the process (see Fig. 1; the different stages are indicated by the small figures). It consists simply in an elongation and constriction of the cell, and finally the formation of a delicate membrane that completely divides the daugter-cells which soon become rounded and entirely similar to the original mother-cell.

In *Cladophora*, a common coarse branching alga found abundantly in running water, the process of cell-division is very easily studied. (Fig. 2–7.) The large cells are multi-nucleate and cell-division and nuclear division go on quite independently of each

other. The nuclei are small and not easily seen in the living cell, but fixing with 1 per cent. chromic acid, and staining with carmine will show them distinctly. They are not often found in division and are too small to be satisfactorily studied, so they will not be considered further here, and we will confine our attention to the division of the cell only.

The young division-wall is first evident as a delicate ring running around the inner surface of the cell-wall, and this rapidly grows inward pushing the protoplasmic cell-body inward until finally the ring closes up completely and forms a thin membrane completely across the cell, cutting the protoplasm completely in two (Figs. 2–6.) The process occupies between three and four hours under ordinary circumstances, and may be readily followed.

In the common pond-scums of the genus *Spirogyra* (Fig. 8) and in many Desmids (Fig. 9.), the cell divides in much the same way as in *Cladophora*, but here the single nucleus divides simultaneously with the cell. In all the common Spirogyras the division takes place normally at night, and in order to follow it successfully the process must be checked. This can be done by keeping the plants in a warm room until nearly the time for division to begin (about 11 P. M.), and then lowering the temperature to near the freezing point. When the temperature is nearly freezing out of doors, this can of course, be done by simply placing the vessel containing the plants, outside. On bringing the plants thus treated into the laboratory, division will begin almost immediately.

After undergoing several preliminary changes, similar to those to be described further on, the nucleus divides into two similar portions which quickly separate and soon assume the form of the original nucleus. They remain connected for some time by delicate threads which disappear about the time the division-wall is complete.

While a good general idea of the processes of cell-division may be had by a study of the lower plants, for understanding the minuter details we must choose subjects from among the higher plants, and while in a few cases we can follow through the process in the living cell, it is usually necessary to have recourse to fixing and staining agents in order to obtain the best results.

Among the flowering plants the mono-cotyledons are on the

whole better adapted for the study of the cell and cell-division than dicotyledons, as the cells are usually larger and the nucleus correspondingly so. Among the very best plants for the study of the nucleus, especially in the cell are various species of *Tradescantia* whose cells are uniformily large with large and distinct nuclei. To follow the division in the living cell, the hairs attached to the filaments of the stamens should be used. By selecting young buds before the purple color is developed and carefully removing the whole stamen with the attached hairs, specimens in all stages of division may be found. If they are mounted in fresh water or a 3 per cent. solution of sugar, there is little difficulty in seeing the whole process in the same cell, as the cells remain alive for 24 hours or more.

In *Tradescantia* as in many other monocotyledons, the pollen mother-cells offer exceptionally good subjects for demonstration. The wild-onion (*Allium Canadense*) is also excellent for this purpose, and either one will enable us to get a good idea of the finer structure of the nucleus as we find it in the higher plants.

In studying the division of the pollen-spores, for quick demonstration they may be fixed with acetic acid and stained with gentain-violet. Such preparations are not permanent, but show beautifully all the details of nuclear-division.

The resting nucleus is separated from the surrounding protoplasm by a thin but very evident membrane, and is usually globular or lenticular in form. As to the nature of the nuclear membrane, there is much discussion whether it is part of the nucleus proper or only an inner layer of the cell-protoplasm enclosing the nuclear cavity. With the latter, and usually invisible in the resting nucleus in its living state, are numerous slender threads the "nuclear filaments," which are closely crowded together and so intertwined that it is almost impossible, even when carefully stained, to trace their limits with any certainty, and until recently it was supposed that they were fused together at certain points, and formed a sort of net-work. This however seems now not to be the case and the filaments are probably entirely separate even in the resting nucleus.

If we treat the nucleus with alcohol, chromic acid or any of the various fixing agents, and then stain it, the structure may be plainly seen. The filaments now show two parts, a colorless matrix, and larger or smaller, deeply stained granules embedded

in it. From the avidity with which these granules take up stains the substance composing them has been called "Chromatin." In many resting nuclei the Chromatin seems to be almost entirely wanting, but as the nucleus prepares to divide, it becomes very abundant, as is shown by the deep coloring of the nucleus at this time.

Besides the nuclear filaments, there are usually to be found one or more nucleoli, rounded bodies that are often very conspicuous. These usually stain deeply, but occasionally this is not the case.

The first indication of approaching division in the nucleus is usually an increase in volume, followed shortly by a shortening and thickening of the nuclear filaments which become much more distinct, and owing to the increased amount of Chromatin in them, color much more deeply than in the resting nucleus. As the preparations for division proceed, the filaments continue to shorten and the Chromatin increases in quantity, the separate granules often coalescing until the filaments appear as short thick loops stained almost uniformily, and very vividly. By this time the nucleolus has usually disappeared and it is still a question what becomes of it.

Presently the nuclear membrane disappears entirely and the nuclear filaments, which have separated more and more, lie free in the centre of the cell. They quickly arrange themselves in the form of a flat disk (nuclear-plate) across the centre of the cell, in the plane of the future division wall (Fig. 10), and now we may see, with care, delicate lines in the protoplasm which run from the disk and converge at the poles of the cell, forming a spindle-shaped figure with the nuclear-plate at the equator. This stage is called the "nuclear-spindle," and probably the number of spindle-fibres corresponds to the number of the segments in the nuclear-plate. (Fig. 10).

About the time that the nuclear plate is complete, the segments, which commonly are V-shaped, divide longitudinally into two equal parts, and as these separate, the points of the two new segments are divided toward opposite poles of the spindle, the angles remaining for a short time in contact.

Now begins the separation of the two sets of segments which travel along the spindle-fibres towards the poles. As they separate, numerous very fine threads connecting them become visi-

ble, (Figs. 11–13), and about the time the segments reach the poles fine granules appear in the centre of the cell, forming a disk at the equator in the place formerly occupied by the nuclear-plate (Fig. 12). Careful examination shows these granules to be thickenings of the connecting threads, and new threads are found with similar thickenings at the edge of this "cell-plate," as it is called, which add to its size until it reaches completely across the cell (Fig. 13), when the separate granules ("microsomes") which appear to be cellulose, coalesce and form a continuous membrane dividing the cell into two (Fig. 14).

In the meantime the nuclear filaments of the two daughter nuclei, undergo in reverse order the changes that were observed in the dividing nucleus, become invested with a membrane, the nucleolus appears, and the new nucleus resembles in all essential respects that from which it came.

The complicated process ("Karyokinesis"), here sketched, we find universal throughout the growing tissues of the higher plants; but as a rule, cells lose this power of division after assuming their permanent form. In a few instances known, among which may be cited the long internodal cells of the *Characeæ*, and *Tradescantia*, a direct division ("Fragmentation") of the nucleus has been observed, resulting in the formation of many nuclei without the complicated process of karyokinesis; but, so far as known, this is confined to cells that have already attained their growth, and never occurs in the actively growing and dividing cells.

It is not the object of this paper to discuss methods, but those who desire to study the subject practically will find some notes by the writer of this paper, published in the Bulletin of the Torrey Botanical Club[1].

EXPLANATION OF PLATE III[2].

Fig. 1.—A filament of *Nostoc* showing stages of cell-division. The successive stages indicated by the figures.

Figs. 2–6.—A cell of *Cladophora* showing the process of cell-division. Fig. 2 drawn at 9:30 A. M. Fig. 6 at 2:05 P. M.

Fig. 7.—A larger cell of the same plant.

Fig. 8.—A dividing cell of *Spirogyra*.

Fig. 9.—A desmid in process of division.

1 "Studies in Cell-division." Bull. Torrey Bot. Club, Jan., 1890.

2 For the use of the plate thanks are due the Editor of the Bulletin of the Torrey Botanical Club.

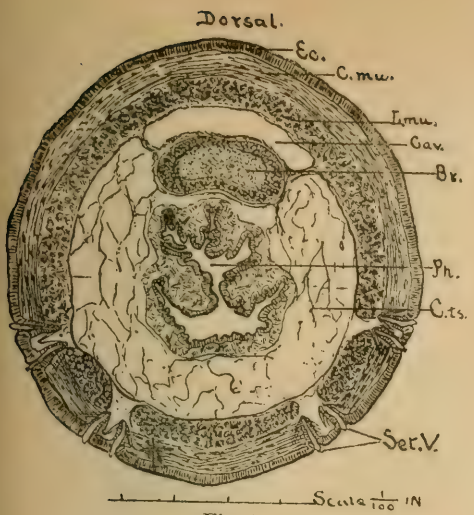


Fig. 1.

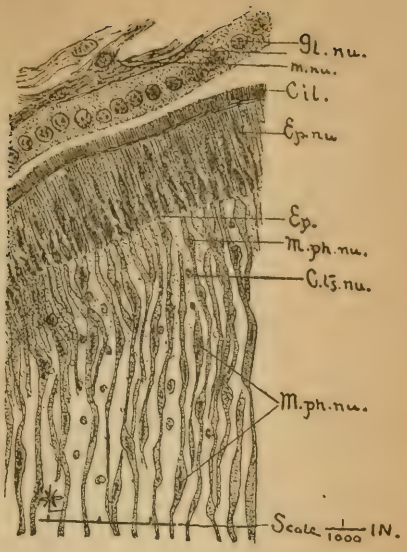


Fig. 4.

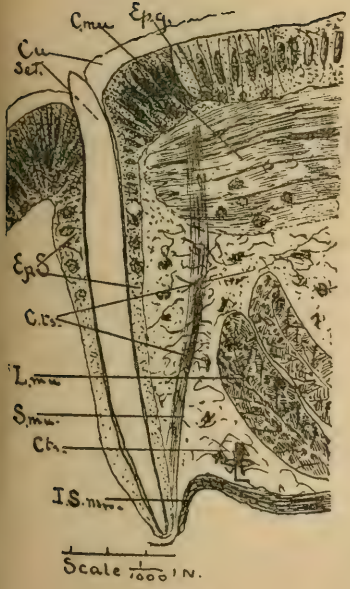


Fig. 3.

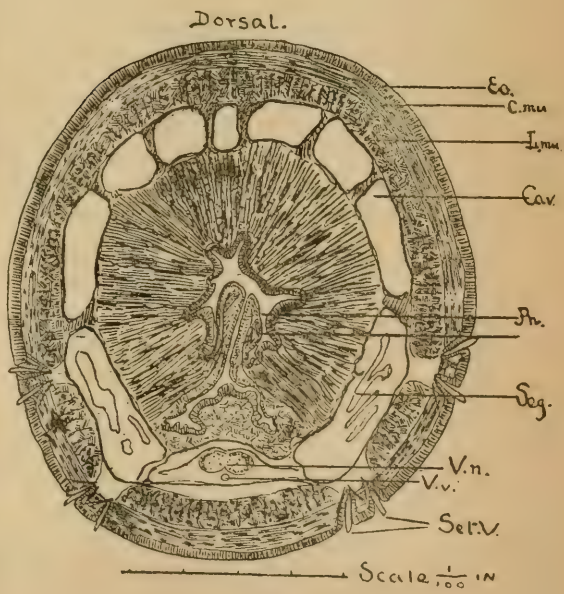


Fig. 2.

Fig. 10–14.—Final division of the pollen-spores of the wild-onion (*alium Canadense*. In Fig. 10 the nuclear-plate is shown. In the cell at the right it is seen in profile, in that on the left from above.

THE HISTOLOGY OF LUMBRICUS, OR THE EARTH-WORM.—I.

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PLATE IV.

THE earthworm by reason of its easy capture, its zoölogical position, its convenient size and its soft boneless structure, has fallen a prey to hundreds of biologists. A large number of excellent researches treating of its histology are now published, but though the subject has not even yet been exhausted, a most active controversy being waged in the current journals upon certain points in the embryology, it is not the present intention to undertake to add any to our knowledge of earthworm histology. The purpose at this time is merely to set forth for the benefit of students the methods of histological study; using this very convenient creature as the subject.

Specimens of *Lumbricus* having been obtained, they must first be subjected to an anatomical examination before any histological study is made, since the interpretation of the histological structure is unintelligible except as the sequel of at least a rough dissection. To prepare the specimen for this study, immerse it in water and add alcohol in small amounts so as to stupefy the creature gradually. When it has become inert and apparently dead, draw off most of the water and add alcohol so as to increase the strength to 30–50, finally 95 per cent. Leave the specimen to harden in 95 per cent. alcohol at least 24 hours. Directions for dissection can be found in any of the numerous guides for the use of students*.

The anatomical study will demonstrate the dorsal and ventral surfaces, the ringed body, the 8 rows of setæ, the body cavity, the large pharynx, the dorsal brain, the nerve collar and the ventral cord, segmental organs in the anterior portion of the

* The book of instruction most satisfactory for the purpase of the general student of this subject is General Biology by Sedgwick and Wilson. For the dissection of the *Lumbricus* sufficient directions are given in the *Invertebrate Dissections* of the writer.

body and sundry additional organs posteriorly. Our histological study will confine itself to the region of the pharynx.

To prepare specimens for histological study a somewhat different treatment is required from that mentioned above. The intestine is full of sand; first this must be removed. The worm kindly purges the organ if we feed him in confinement in a glass vessel, on moist blotting paper. The paper is eaten as hunger begins to be felt and traveling the length of the intestine pushes the sand before it. The specimen thus freed from grit is now to be killed, by the addition of alcohol to the water in which it has been placed. As soon as no signs of life are seen the specimen may be preserved by any of the numerous, well known methods. One, perhaps the best for the majority of the students, is the picric acid mode. To pursue this proceed as follows: First make a saturated aqueous solution of picric acid, then add to a bulk of this 2 per cent. of concentrated sulphuric acid. An abundant precipitate will fall which filter out and throw away. Dilute the filtrate with 75 per cent. of water, and you have a solution very useful for a general hardening reagent. The worm is to be placed from the weak alcohol in many times its bulk of the picric acid solution and kept there for 6 hours. The picric acid is then to be replaced by 30, that by 50 and that by 70 per cent alcohol, the specimen being left 5 minutes in 30, and 30 minutes in 50 per cent. and kept in 70 per cent. which should be frequently changed until no further yellow color is imparted by the specimen to the alcohol. The specimen thus hardened is next to be stained; this may be accomplished by leaving it in borax-carmine 24 hours, then after brief immersion in weakly-acid alcohol, it is passed successively through 70, 80, 90 per cent. to absolute alcohol, and then embedded in paraffin and sectionized. The details of this method are so well known and have been so often described that it will hardly be worth while to detail them any more fully, except to say that specimens must not be left too long in the weak alcohol which macerates the cellular structures, must have the picric acid thoroughly removed by alcohol to permit successful action on the part of the staining reagent, must not be transferred from alcohol much below 100 per cent. into turpentine or the turpentine will not pervade the tissue, and must not be heated above 68°–70° C. during the embedding. Any one who gives close attention to his reagents and

to the process of histological preparation, cannot fail of making sections which show all that a section can show.

The goal of too many has been reached when this point is attained. The section collector however goes through all the drudgery of the desert and never once sets foot upon the promised land. The real purpose of this article is to study sections of *Lumbricus* to see what they can tell us which we could not see in an anatomical study. Here is a section from a series of successive slices cut the length of the body. This section is about the one hundred and fourth in the series beginning with the front one. It is seen at a glance to consist of three principal parts, the skin, the brain and the alimentary tube. We are examining it with a low power. We are very much tempted to put the high power on at once to see more clearly some little part which catches our eye, but this temptation must not be followed; for if it is we shall go on chasing over the section and completing nothing. So we give our attention first to noting the parts before us and trying to read from them the structure of *Lumbricus*. First of all we note a thin translucent boundary line represented by the heavy black line of figure 1, interrupted only at 8 points where the setæ come out through it. This is the cuticle. Just within the cuticle a distinct layer but of small bodies vertical to the surface encircles the section. This belt is also interrupted at the setæ and can be seen to bend in to form pits which the setæ fill. The layer which thus covers the body externally just beneath the cuticle is the ectodermal portion of the skin, the vertical elements barely visible under the lower power are the units or cells the more careful study of which will be better deferred until the general anatomical relations of the section have been fully determined under a low power. Directly under the ectoderm a belt *c. mu.* parallel with the last is seen. It is composed of elements which are parallel with the surface marked here and there with elongate deepened spots. This belt is also interrupted at the positions of the 8 setæ, but is otherwise continuous throughout the section. It is the "circular-muscle" layer of the skin, the fibres of the muscle long and thread-like being wound around and around the body are seen lengthwise in a cross section. Another muscular layer appearing very unlike *c. mu.* is seen within it forming the inner or longitudinal muscular layer. This is composed of fibres which run lengthwise in the body-wall and

are cut so as to show their ends in a cross section. Inside these layers a thin but definite lining covers the skin or body-wall. The thickness of the body-wall can be seen by reference to the scale printed on the figure, to be about one one-hundredth of an inch. The skin is seen further to be similar in all parts of the section. On the back or sides, or below, the levels of the four pairs of setæ are shown and certain details of their anatomy may be made out.

In the centre of the section figure 1, an irregular space definitely bounded can be observed. This space is the cavity of the pharynx, the most anterior organ of the alimentary system. This is bounded everywhere by a wall of vertical elements somewhat like those of the ectoderm in appearance. There are no breaks in the continuous wall which they form, not even in the corners (unless some accident of preparation has torn them from their natural position). This layer, the pharyngeal epithelium, is covered by a second layer in the wall of the organ which is muscular tissue used in moving the food contained in the pharnyx. The pharnyx is held by connective tissue which forms a spongy network reaching across to the body wall on either side. Above the pharynx however there is a space *cav* the body cavity part of a system of spaces of more importance in other regions of the body. Between the space and the pharynx lies a structure plainly an organ of importance. It is finely granular throughout, and around the margin of its rounded outline is a zone of rounded bodies. It is the brain, and the rounded bodies are nerve-ganglion cells. The brain is enclosed in a sheath of its own formed by a more compact arrangement of the connective tissue.

If we compare the section figure 1 with that figured at 2 we shall find that internal anatomy of *Lumbricus* presents very much more considerable contrasts upon comparison of different regions than the great similarity of different external portions might lead one to expect. Here the body wall is the same as before, presenting cuticle, ectoderm, circular, and longitudinal layers, interrupted at the situations of the four pairs of setæ. In the centre also the vertical epithelium cells form a skin covering completely the cavity of the pharynx. But the pharynx is plainly divided into two portions one above and one below united by a median portion, and even the low power shows that there is

a difference in the epithelium in the two parts. The muscular coat too is thick and extends to close neighborhood with the body wall. There are spaces between the pharynx and the body wall across which threads of connective tissue reach; the spaces are the continuation of the body cavity, a large space in the posterior regions of the body, and reduced to a very small one anteriorly (Fig. 1, *cav*). The brain as seen by the dissection has disappeared, but on the ventral side is the section of the nerve cord *p n*, which continues along this side of the body to the posterior end. It is seen in the dissections to be connected with the brain by a cord of nerve tissue which runs around the throat. Below the ventral nerve (still in figure 2), runs a small vessel *v. v.* easily seen in sections. It is the sub-neural blood vessel. Upon either side, in the body cavity, lie the portions of a tube cut through in several places; the pieces in section seem separate, but they are different parts of the segmental organs, a pair of which is present in each somite. A study of sections intermediate between figures 1 and 2 will demonstrate the nerve cord which, diverging from the ventral cord and embracing the pharynx, unites above to form the brain.

Having demonstrated these points with the low power we can now apply the high power to the futher and more exhaustive study of certain points in the histology of the pharyngeal region of *Lumbricus*.

CYTOLOGY OR CELLULAR BIOLOGY.

VIII.—PROTOPLASM AND CELL-MEMBRANE.

ORGANIZATION, CHEMICAL COMPOSITION, PHYSIOLOGICAL FUNCTIONS.

REV A. M. KIRSCH, C. S. C.

FROM the historical sketch of Cytology the reader has learned that in the words of Sachs, "Protoplasm is a universally known and yet an essentially unknown substance."

It would lead us too far to express all the views held concerning this essential substance, necessary as a physiological substratum to those phenomena which are included in the comprehensive term life. Every investigator has his own views concerning the nature of protoplasm, and it is not my intention to deny any one the right of forming and holding an opinion; nay, more, I claim also perfect freedom in accepting any opinion which best

agrees with my own views and observations. I may therefore be permitted to state that I accept the opinion of von Mohl concerning the general structure of the cell. If some day a cell is found which has no membrane and nucleus, I will say with von Mohl that such a cell possesses only one element, the protoplasm, but if this protoplastic mass shall have organized the two other elements, the membrane and the nucleus, then again I say with von Mohl, that these two must be regarded as distinct structures in the cell. A typical and completely developed cell, therefore, contains these three elements: a membrane, protoplasm and a nucleus.

There should be no great difficulty in pointing out, at least anatomically, that portion of a cell called the protoplasm; in fact, I imagine the reader has not even waited for me to state that the protoplasm in a cell is that portion which is found between the membrane and the nucleus; and this is correct if we have before us a cell in which there is no intrusion of foreign substances, and no elaboration of other substances in the protoplasm, such as aleurone, starch, chlorophyll bodies, etc.

Protoplasm is organized. We have already seen that protoplasm has a structure, *i. e.*. it is organized. In fact, we may distinguish in protoplasm a fibrous network, which for want of a better term may be very appropriately called reticulum. The meshes of this reticulum are filled with a plastic fluid, which is granular, and to which Carnoy has given the name enchylema. A rough but sufficiently exact idea of the structure of protoplasm may be obtained by imagining a most delicate sponge in which the spongy framework is replaced by a simple and very delicate network of fibres, and the meshes filled with a hyaline, viscous and granular substance. There is no difficulty in observing this structure; the class of animals presenting it most strikingly are the Arthropods. This fibrous structure of protoplasm has formed the subject of discussion ever since it was first observed by Remack.

The question has been raised as to whether these fibres are separate, and only irregularly distributed in the protoplasm, or whether they constitute a true network. Flemming leaves the question undecided. He declares that after having studied the Cytology of Arthropoda, there remains no doubt in his mind concerning the true reticulate nature of the protoplasmic fibres.

For a full exposition of this opinion, I refer the reader to Carnoy's work.

Let us now see how these terms can be brought into harmony with those used by other authors. Some writers on the cell say that protoplasm is composed of hyaloplasm and microsomata. What Carnoy calls reticulum represents a portion of the hyaline and fundamental mass in which it is immersed and enclosed, and which is that portion of the enchylema of Carnoy serving as a sub-stratum for the granules or microsomata.

What Hanstein calls enchylema with its microsomata represents only a portion of the enchylema of Carnoy, for besides that granular, fluid portion sometimes circulating along the threads or plastic sac, there is often also a layer of the hyaline mass of variable thickness on the plates or threads of the fibrous portion of protoplasm which also forms a part of the enchylema of Carnoy. Hanstein's enchylema therefore represents only the more fluid portion with the granules of Carnoy's enchylema, and excludes the more or less viscous portion closely adhering to the threads of the reticulum; this latter portion also belongs to the enchylema of Carnoy.

The reticulum of Carnoy corresponds to the *mitom* of Flemming, and to the protoplasm of Kupfer, and Carnoy's enchylema corresponds to the paramitom and paralasma of the same authors.

The term reticulum is more correct than that of mitom as used by Femming, because the latter originally means the weft of a weaver, and therefore does not necessarily imply the idea of union between the various threads so as to constitute a true network; moreover, the term mitom reminds one too much of the terms stereom, hadrom and leptom used only to signify certain vegetable tissues.

Be it stated here then, once for all, that the enchylema is as essential a part of living matter as is the reticulum, and both belong essentially to the protoplasm; this is important to bear in mind, since the term protoplasm will always be employed to signify living matter in general. Each of the constituents of protoplasm has its own chemical composition and also its own physiological function and is, moreover, morphologically distinct.

II. CHEMICAL COMPOSITION OF PROTOPLASM.—Concerning the ultimate and even the proximate chemical composition of pro-

toplasm very little as yet is known. In general it is stated by various writers that the protoplasm is composed of the ultimate elements of carbon, oxygen, hydrogen and nitrogen, and possibly sulphur, the latter being sometimes found in it in small quantity. According to all appearances the reticulum contains a great quantity of plastin or some such substance, which makes it more resistant to the dissolvents of ordinary albuminoides. Lecithin is also probably present, as well as some of the globulins, as vitellin and myosin, especially in young cells. At all events the quantity of plastin increases with the age of the cell. The reticulum also appears to be saturated with water, holding in solution some of the soluable substances of the surrounding enchylema.

The enchylema contains all the other substances composing protoplasm, such as the nutritive matter introduced and as yet not assimilated, etc.; therefore, its chemical composition must necessarily be very complex and very inconstant.

III. PHYSIOLOGICAL FUNCTION OF PROTOPLASM.—It is probably true that the reticulum alone is endowed with the properties of irritability and contractility; it alone therefore, possesses the power of effecting physical movements; the enchylema, on the contrary, remains always more or less passive in all such phenomena.

The enchylema, however, is the seat of all chemical movement, such as the elaboration, the preparation, the digestion and transformation of the nutritive principles; but as to the cause and origin of the circulation of the more fluid portion of the enchylema, I hesitate to pronounce myself; much study and observation are needed to give a satisfactory explanation of this phenomenon, but that it is connected with the nutrition of the cell appears to be the general opinion.

IV. INCLAVATA AND INCLUSIONS.—In young and even in many adult cells, we find no other elements in the protoplasm than the reticulum and the enchylema; but this is not always the case. On the contrary, there are often present in the protoplasm bodies of various shapes and sizes and differing greatly as to their nature, such for example as grains of starch and of aleurone, fat globules, granules and scales of vitellin, vacuoles, crystals, etc.; even foreign bodies are sometimes found in the protoplasm, such as Diatoms, Desmids, red blood corpuscles, grains

of sand, etc. Some of these bodies are formed in and by the protoplasm and are therefore true products of it; these we may call very appropriately inclavata; whilst others are introduced from the outside and such we may call inclusions. All these bodies must be carefully distinguished from the protoplasm itself. Many writers, especially those treating of eggs, have misunderstood this important point, by considering the scales and granules of vitellin as belonging to the plasmatic substance, instead of regarding them as simple inclavata.

There is sometimes great difficulty experienced in drawing a clear and precise distinction between the granules or the so-called microsomata of the enchylema, and the inclavata proper, because the latter first appear within the enchylema as minute granules, and only when they have attained to a considerable size is it possible to identify them as true inclavata. Practically speaking, all granules may be considered as belonging to the enchylema, as long as they do not modify the arrangement of of the threads of the reticulum; and those are to be considered as inclavata when they press against the threads of the reticulum and interfere with their general arrangement.

V. THE MEMBRANE OF THE CELL.—The protoplastic mass is externally limited by a true membranous layer, which von Mohl calls primordial utricle. This layer is formed by a differentiation of protoplasm; and in general is in close structural relation with the protoplasm itself. This membrane, retains often for a long time, the same structure as the protoplasm, being composed also of a reticulum and of enchylema. It is always closed and has neither pores nor markings of any kind.

When we say that every cell has a membrane, we do not mean to affirm that every cell has a solid membrane distinct from the protoplasm; all we mean is that every cell has at least a membrane such as von Mohl calls primordial utricle, and which others have called limiting layer or membranous layer, etc. Carnoy's researches have convinced him that in spite of all criticism, the primordial utricle of von Mohl is to be found in all cells. Pheffer (1877) confirms this view when he declares that it is this primordial utricle which regulates the relation of the internal protoplasm with the outside world.

The solid cellulose membrane which is often formed by a differentiation of the outer layers of the primordial membrane of

von Mohl, serves different purposes in the economy of the cell. In general, we may say, that it is either simply protective or supporting, as in the case with the cells composing the vegetable fabric of higher plants, when it even becomes lignified.

Since the researches of M. Schultze, many have denied the existence of a membrane in those cells endowed with amœboid movements, but we can easily find cells with an evident membrane, which still possess this amœboid movement in a remarkable degree, for example the testicular cells; and such may be found abundantly in the Arthropoda and especially in the class Myriapoda.

In conclusion, I would say that this living membrane is not that solid and differentiated structure commonly regarded as cell-membrane. This would be just as incorrect as it would be wrong to consider the cuticle of the skin of animals or the epiderm of plants as the true and real, active, living skin or layer of the bark; further we do not maintain that in all cases this true membrane of the cell persists, but it is a fact not to be called into question that often the reticulum of this membrane becomes differentiated into plastin, keratin, elastin; and that the enchylema is often replaced by air or by cellulose, chondrin, gelatin, conchiolin, chitin, etc., etc., while the membrane often becomes incrusted with mineral substances either calcareous or siliceous.

The term membrane therefore is justified in all cases, and it may be used in its proper sense quite as well as other terms, such as membranous layer, limiting membrane, primordial utricle and others which are synonymous.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XIX.

AIR AND OIL BUBBLES, THE BROWNIAN MOVEMENT, THIN GLASS.

RATHER than take up space by an attempted description of air bubbles, I recommend the reader, if he be not already familiar with them, to follow the plan suggested by Prof S. H. Gage in his "Notes on Microscopical Methods," and make bubbles for examination. He will then know what they are, how they look and how to recognize them when they unexpectedly

occur. Air bubbles and oil drops both appear with a bright central spot and a broad dark border. To obtain the former Prof Gage suggests that a drop of mucilage shall be placed on a glass slip and beaten with a broad blade until it looks milky on account of the inclusion of air. Put on a cover glass but do not press it down. With this under the objective, focus upward and downward, noticing that in focussing up, the central bright spot becomes very clear and the black ring very sharply defined, until the whole is dimmed by being far beyond the focus. As Prof Gage also says, the air bubble is one of the most useful means for ascertaining whether or not the illumination is strictly central; if it is not, the bright spot will not be in the centre of the bubble, as it will be if the light is strictly axial. And if the mirror be swung to one side so as to make the illumination oblique, the bright spot will appear on the side of the bubble *away from* the mirror. This is an important experiment to make whenever in doubt in this connection, as precisely the opposite effect obtains in the oil drop, the bright spot, when oblique light is used, then being on the *same* side with the mirror. Oil drops may be prepared for examination by beating together a drop of mucilage and one of clove oil.

The beginner may have more trouble in experimenting with oblique light than with central. About all that I can tell him is to swing the mirror to one side, usually toward the right hand as being more convenient, and then to manipulate it until the light is properly reflected on the object, the degree of obliquity of course varying with the position of mirror-bar, the mirror or both. Frey in his work entitled "The Microscope and Microscopical Technology," says that "Considerable practice is requisite with oblique illumination. The aperture of the stage must be freed from diaphragms, or any other apparatus that may be under the stage, and the various positions of the mirror are to be tried while the eye is looking into the microscope. Truly diabolical illumination is thus sometimes obtained, which, however, shows many fine details in an astonishing manner." Oblique light as previously remarked, is chiefly used in the resolution of the fine lines on the surfaces of Diatoms, these little ridges not being too minute to cast a shadow on the side opposite to that from which the light is received. Oblique light is occasionally used to produce delicate shadows when the micros-

copist is studying other objects, yet the effect is rarely employed. In such cases, however, when the mirror is swung far to one side, and the objective is not properly corrected, the result is just about what Dr Frey calls it, truly diabolical.

The Brownian movement or pedesis is that continuous quivering or dancing common to all minute particles when suspended in water. It is not an evidence of life, and must not be mistaken, as it is apt to be mistaken by the beginner, for minute living creatures. It may be seen to good advantage by rubbing up a little gamboge or carmine in water, allowing the larger parts to settle, and then examining a drop of the supernatant liquid with a high power objective. The field will be full of dancing and trembling particles, moving irregularly but as if endowed with life. Similar movements are beautifully visible within certain Desmids and Algæ, especially if they are not in a healthy condition. The minute black granules then hover together, and swing and quiver like a swarm of microscopic bees. It is also noticeable within the little sacs near the base of the spinal nerves of the common frog, and in almost any place where finely divided matters are in suspension. The cause of the movement is not known. An explanation is that it is produced by currents of heat. How long it lasts is not known. One writer claims to have prepared a slide which he examined at the end of seven years and found the particles as active as at first. Soap and water are said to produce an energetic pedesis, and it is claimed that our hands are cleansed as effectually by the violent pedetic movements of the soap, as by its chemical action. In any event, do not mistake this uncertain dancing as seen under the microscope, for the quivering of minute Bacteria or for other living plants or animals.

In addition to the three foregoing microscopical bug-bears, which cease to terrify when well known, the student should make himself familiar with the appearances of starch granules, and with cotton, woolen and linen fibres, especially when colored, as woolen fibres are apt to be if the work room is carpeted, as it should not be. I can scarcely imagine an object any more stonishing on first acquaintance than a purple fibre from the arpet or elsewhere. These, with cotton and linen, are likely to be found in any preparation; even in mounted slides they are common, having fallen into the mounting medium or been en-

tangled in the object itself. The beginner may mistake them for something more important unless he makes himself familiar with them at the beginning of his studies.

The difference in the appearance of convex and concave bodies is also important and useful. Microscopical and ordinary vision differ so widely from each other that it is often impossible to decide whether a surface is convex or concave, especially if the object be uniformly covered with markings that may be bosses or depressions; sometimes the same trouble is experienced by the naked eye. Grooves belong in the same category with depressions. To whom belongs the credit for discovering the means of discriminating between these conditions, I do not know. My impression is that it is due to Prof John Quekett, an English microscopist who is remembered for his microscopical work and discoveries. The means of discrimination however are simple. When the objective is racked upward, a convex surface will appear lighter; a concavity will appear lighter when the objective is focussed downward.

It is often difficult to find a small object and bring it into the field. This is especially true with high powers, the trouble increasing with the increase of magnification, because the actual field of high power objectives is so small that the chances of escape for the small object are much greater than are the microscopist's for capturing it, especially if the mechanical stage be not used. The only recourse is to remove the high power objective, substitute a lower power, find the object, place it in the centre of the field, and then to re-attach the high power lens, when the object sought should be somewhere within the illuminated space.

The majority of objects are examined in water, glycerine, Canada balsam or some other liquid medium. As a rule opaque specimens, if they cannot be made transparent, are studied dry, that is surrounded by air alone. Few naturally transparent objects are ever mounted dry, although there are exceptions to this rule. When the specimen has been placed on the glass slip, and immersed in the drop of Canada balsam or other preservative medium, a thin glass cover is added to flatten the rounded surface of the drop, to prevent the intrusion of dust and of moisture, and to protect the front of the objective. The mounting medium also has an important effect in an optical way. When the preparation is dry, the object is placed on a slip within a

cement or metal cell, and the thin glass cover applied to keep out the dust, and often to hold the specimen in position. The art of mounting objects for microscopical examination is an attractive one, demanding much good judgment, care, skill, neatness, and delicacy of touch. A neatly finished slide is often a beautiful thing, aside from the beauties of the included object visible to the microscope alone, but it is in no way essential to the study of the specimen. The microscopist, oftener than not, mounts his objects temporarily, using a drop of water or of glycerine, allowing the thin cover to cling by capillary attraction, removing it and "cleaning up" when the examination is finished. Some objects cannot be permanently preserved. It is then necessary to study them as temporary mounts or not at all. Living creatures, whose life-history or the action of whose organs is to be observed, must be arranged in some way that shall not interfere with their freedom, except so far as is necessary to restrict them within a limited space.

The thin glass prepared to prevent evaporation or as a protection to the objective or to the object, is an important substance to the microscopist, since it is used for all the foregoing purposes, and for more. Before it was obtainable as easily and cheaply as at present, microscopists used very thin pieces of mica, and for use with exceedingly high power objectives whose working distance is excessively short it is to a certain extent still used. In this case it is advantageous, as it is not easily broken, and since its flexibility protects the front lens of these very costly objectives. For ordinary purposes, however, thin glass is employed and is preferable. The older microscopists preserved their objects between two pieces of window glass.

The method of manufacturing this thin microscopical glass is a secret known only, I believe, to the Messrs Chance, of Birmingham, England. Some time ago the report passed the rounds of the journals to the effect that a method of making it had been discovered in Germany, and that it would soon be supplied very cheaply, but nothing further has been heard from it of late. All that is used in this country is imported in sheets, and cut by the dealers into circles or squares of various sizes. A suggestive remark in this connection is made by Dr S. Czapski when writing of the peculiar cover glass needed for use with Zeiss's latest apochromatic objective of 1.63 N. A. He says, "The production

of these cover glasses in the usual way—by blowing in a furnace —was forbidden by their substance." Further than this the method of manufacture has not been explained.

IT frequently happens that the amateur microscopist would study the epidermal cells and appendages of the almost infinite variety of leaves, the structure of the cellular parenchyma, or body substance of the leaf, the peculiarities of the cells and vessels of petals and of other parts of flowers. That is, he would if he could. It is sometimes an easy task to strip off the epidermis and to examine its cells, while in other cases it is almost impossible. Many chemical mixtures have been recommended for the purpose, and they accomplish the object after a fashion. The structure of the body of the leaf may be satisfactorily studied in sections, but not every microscopist can have a good microtome: a poor one is an abomination. There is also much to be learned and much beauty to be seen in the petals of flowers and in the cuticle and cells of the anthers, but it has been almost impossible to succeed here without special and somewhat complicated processes. Yet there is a way to make these objects either entirely transparent or sufficiently translucent to render their study pleasing and comparatively easy. The dealers will supply the microscopist with mounts of entire flowers made beautifully transparent, but the method of accomplishing this is not detailed with any spontaneity; indeed the preparers, so far as I have been able to observe, are deaf and dumb when the subject is mentioned in their presence. I possess a fine slide of the entire flower of the common *Houstonia*, or "Innocence," perfectly transparent, so that the cells of the epidermis, of the substance of the petals and of other parts, and the anthers with the pollen grains *in situ*, may all be examined with a high power.

How the thing was accomplished I have, until recently, been unable to ascertain. The secret has been so well kept that, so far as I can learn, only the dealers knew it; the books

have not discovered it. Yet by a very simple method these objects as well as leaves may be made entirely or almost transparent, so that the vessels and the cells may be studied at one's leisure and in comfort. By this treatment the hair-like and glandular appendages and stomata are preserved in place and in structure, the protoplasmic contents alone being contracted toward the centre of the cells. It is a method that I have stumbled on by accident, but one that I can recommend to the microscopical botanist that desires to examine these parts without destroying or disarranging any of the constituents.

Place the petal, the anther, the whole blossom, or a part of a leaf on the slide in a large drop of glycerine. See that it is completely submerged beneath the liquid, and add a large cover glass. It is best to use a slip without a cell. Then boil the glycerine over the lamp flame until the parts are entirely transparent or at least translucent, a condition that will arrive in a short time. Do not allow the boiling to be so violent as to disarrange the thin glass; let it be so gentle that the bubbles will run one by one to the edge of the cover and there break. If the glycerine should become discolored, as will often happen when leaves are under treatment, draw off the liquid by a wet cloth and add fresh glycerine, repeating the process and the boiling until the leaf is saturated. The use of glycerine and the saturation of the cells form the secret of the process. The saturation is easily accomplished with petals and similar delicate parts; with thick and opaque leaves the time demanded is longer, and the specimen may become only translucent. I have made the thick and opaque leaf of the garden geranium, *Pelargonium*, so translucent that there was no difficulty in examining the hairs on the surface, the epidermal cells, the parenchyma and vessels, with the cells of the epidermis on the opposite surface. Of course there is a limit to the thickness and to the opacity that can be overcome, yet the method will be found exceedingly useful. Leaves and petals do not entirely lose their color, although they become beautifully transparent. Of course the specimens must be permanently preserved in glycerine.

The secret that the dealers have seemed to keep so carefully, and that the books have ignored because apparently their authors had not learned the process, is here placed at the reader's disposal. I am sure that he will be pleased with the result of

his experiment, and that he will find the objects so often mentioned, rendered easy of examination. Petals and other parts of the flower need no previous preparation. It is well however to cut the leaves so that there shall be two or more open surfaces for the penetrating of the glycerine. In some very delicate specimens this will not be necessary; it is so when the leaf is thick or very opaque.

ACKNOWLEDGMENT.—To Mr Fr. Dienelt, of Loda, Ill., for several insect preparations. Mr Dienelt is doing excellent work in insect anatomy, especially in connection with tracheæ that are internally hairy. The list of insects in which these inexplicable appendages are found is a long and lengthening one. The subject seems to have attracted absolutely no attention till brought to light some time ago in THE MICROSCOPE.—To Prof John H. Miller, Ph. D., of Buffalo, N. Y., for a slide of tube casts, stained and mounted in balsam.

NEWS · FROM · THE · WORKERS ·

The ventricles of the frog's brain and the central canal of the spinal cord are lined by a ciliated epithelium which has recently been studied by A. C. Wightman[1], who states that it forms a continuous lining to the central nervous system, being a single layer of ciliated cells in thickness; those of the ventricals form a central zone, about which the brain cells are concentrically arranged; the cells of the epithelium and of the brain are connected by often branching processes extending from the tips of the former; the epithelial cells being columnar, spindle-shaped, and of intermediate forms. The cilia of the living cells beat at the rate of from one hundred to two hundred strokes per minute. No wave of ciliary movement is visible, each cilium acting independently of every other, and often at a different rate. Each beat consists of a quick stroke and a somewhat slow recovery, the vigorous strokes being always directed posteriorly.

1 Studies Biol, Lab. Johns Hopkins Univ.

THE SPECIFIC CAUSE OF TYPHOID FEVER.—In 1880 Eberth found, in the spleen, swollen lymphatic glands and in the pathologically changed parts of the intestinal tract of patients who had died of typhoid fever, a Bacillus which he was led to believe to be the specific germ of this disease. In twenty-three cases he found this micro-organism twelve times. He found the Bacillus the more frequently the earlier in the course of the disease the patients died.

This micro-organism is described as a motile Bacillus three times as long as broad, with rounded ends. Sometimes it forms long threads. With the aniline colors it does not take so intensive a stain as most other similar organisms. Its growth is slow. When sporulation occurs the spores are contained in the ends of the rods.

Independently of Eberth, Koch had studied this same Bacillus and found it in one-half of the cases examined, and had put his work on record in the form of a series of photographs of the micro-organism before Eberth's first work appeared. Meyer also in 1881 reported the finding of this Bacillus in sixteen out of twenty cases[2].

A bacillus has been discovered in sections of warts, which is always present in the prickle layer. It has distinctive qualities as regards its capacity for color, and is found both between and in the cells[3].

WAYS AND MEANS

LEDGE.—Spring-clips, however useful generally, at times are a hindrance, and something to rest the slide against, with perfect freedom in movement, becomes a desideratum. A very good makeshift, for square stages only, can be made from a strip of sheet lead of suitable thickness, about one-sixth of an inch broad and sufficiently long to reach over and clasp the stage somewhat firmly. It can easily be pushed up and down.—*Hans M. Wilder.*

2. Report Maine State Board of Health, 1888.
3. Journ. Am. Med. Ass'n.

FELT-TIPPED PLIERS.—Every one has experienced the difficulty of using pliers or forceps of the ordinary pattern in handling delicate and slippery tissues. If the corrugations are sufficiently sharp to be of service, there is much danger of lacerating or perforating the membrane. This is true in the dissection of amphibia with mucous glands in the skin, as well as in the mucous and serous membranes of other vertebrates and of the meninges of the brain. This difficulty may be almost entirely obviated by gluing to the points accurately fitted pieces of close-textured felt or chamois skin, which facilitate steady and firm tension without danger of laceration.—*Prof C. L. Herrick*[1].

AN ALMOST UNTRODDEN FIELD for research, suggests J. B. Farmer in the *Annals of Botany*, is to be found in the morphology and physiology of the pulp of succulent fruits.

PRESERVATION OF URINE FOR EXAMINATION.—In order to arrive at the true condition of a sample of urine, the earlier it is examined the better. It is however sometimes impossible to obtain it for examination for many hours, or even days, after it has been passed, and it is then often entirely changed. Various substances have been recommended as anti-ferments and preservatives, but all have objectionable features. Accident recently led us to try napthalin, and the results were as gratifying as they were unexpected. Though the substance is well nigh insoluble in water, and a crystal added to urine remains unattacked, so far as appearances go, for days, a very minute quantity of it sufficed to preserve a couple of ounces of urine apparently unchanged for several days.—*National Druggist.*

CORN SILK AND POLLEN.—Early in the morning, before sunrise, pollen was sprinkled upon a silk just protruding from the shuck; after five or six hours the ends of the silk were cut off, put in camphor water, and after several days mounted in the same. By focussing up and down the pollen tubes may be seen. The pollen must be sprinkled on a *fresh* silk early in the morning while it is damp. If no tassel can be found ready to shed its pollen, cut off one and hang it in the sun; in half an hour or more it will shed it copiously. In four or five hours hundreds

1 Journ. Comp. Neurology.

of tubes will be found penetrating each silk. If the silk thus specially fertilized be mounted in some suitable medium (water will answer), and examined, many of the grains may be seen in the act of discharging their contents. I have never been able to ascertain exactly how far the tube penetrates the stigma, but not more, I think, than a millimetre or two. The protoplasm after leaving the pollen tube, by pressure from behind and capillary attraction, passes rapidly to the ovary. It passes out in a constant stream and takes about fifteen minutes to empty the grain. —*J. M. Barrow*[2].

MOUNTING FRESH WATER ALGÆ.—I have tried many media for mounting fresh water Algæ, and find the best to be a solution of acetate of potash in water. It does not alter the chlorophyll, and preserves the color fairly well in most species—perfectly in some. One fluid ounce of water to half an ounce of potash is the recipe. Should anything like crystals form in the mount, the solution should be weakened by the addition of water. Farrant's medium is the next best; I often use it, and produce most satisfactory results; but the object to be mounted in it must previously remain for a couple of minutes in the "1, 2, 3," or "Gwa" mixture. The "Gwa" mixture is composed of glycerine 1 part, water 2 parts, alcohol 3 parts. After this preparation the Farrant does not effect much alteration of the chlorophyll.—*H. W. Lett*[3].

RINGING MOUNTS.—For peventing the finishing cement from running under, I have been using a solution of gelatin and gum arabic, about 60 grains of each to the fluid ounce of water and colored with some aniline dye. In using it, ring a narrow band of it around the edge of the cover glass and slide and allow to dry; when dry it is ready for the finish. It is best to apply two or more coats of the gelatin and gum solution so as to ensure complete covering for the resinous medium. Having tried it for some time, it seems to be satisfactory and does very well. Since parafin has been recommended for the same I have tried it, and it is as good, but requires quicker manipulation. Parafin is the best substance for pure carbolic acid cementings, as all other cements are disolved or softened by phenol.—*J. E. Huber, Ph. G*[4].

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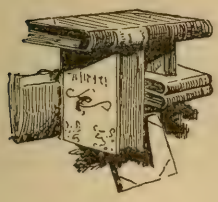
2 An. Rep. Am. Postal Micros. Soc. 3 Science Gossip. 4 Meyer Brothers Druggist.

STAINING SECTIONS[5].—According to Zacharias the very finest cellular structures may be rendered plainly visible by coloring them with an ammoniacal solution of carmine, to which a surplus of acetic acid has been added, and afterwards allowing them to remain for from two to ten hours in a weak solution of ferric sulphate. This is a very useful method for bringing into view the nuclei of many zoological and botanical objects. The black coloration appears to be quite durable.



NEW PUBLICATIONS

MANIPULATION OF THE MICROSCOPE. By Edward Bausch. 16mo., pp. 128. Second edition. Rochester: The Bausch and Lomb Optical Co.—The first edition of this admirable little book is so well known, and has done so much good service in enlightening microscopical novices, that scarcely more is now needed than to call attention to the new edition and to the changes made in it. The practical part of the work is not limited to a few pages; it fills them all. The book contains more important matter concisely explained and intelligently selected than any other elementary work on the subject with which I am acquainted. Mr Bausch has here given the inquiring student just the information that he is anxious to have, and that he will certainly fail to find so well displayed elsewhere. The little book deserves every commendation and is open to not a word of adverse criticism. Even the learned microscopist must find in its pages several things that he either never knew or has forgotten; and to the novice that desires to have some knowledge of the optical parts of his instrument the book can be cordially commended. It is written by a man learned in his subject. His remarks are therefore bright and lucid. The changes in the present edition are only those needed to include the advances made since the first was issued.

5. Druggists Circular.

LE DIATOMISTE, Journal spécial s'occupant exclusivement des Diatomées et de tout ce qui s'y rattache.—It is a pleasure to be able to call attention to a periodical as valuable as this and devoted exclusively to the study of the Diatoms. The man that should even think of issuing such a magazine in this country would be looked at askance, and left to enjoy his publication alone; but in Europe such things appear to be done differently. "Le Diatomiste" is a quarto, published every three months, exquisitely illustrated with photo-gravures, and apparently well supported by the diatomists of France and of other European countries. No American student of the Diatoms can afford to neglect it, especially since it is now publishing a monograph of *Pleurosigma*, profusely illustrated, and describing every known species. The magazine is ably edited by M. J. Tempère, 168 Rue St–Antoine, Paris, the subscription price being only 15 francs. The journal merits the greatest success.

SIX CENTURIES OF WORK AND WAGES—A History of English Labor—By J. E. Thorold Rogers, M. P.—With Charts and Appendix by the Rev W. D. P. Bliss.—Introduction by Richard T. Ely, Ph.D.—Price 25 cents.—The Humboldt Publishing Co., Astor Place, New York.

This is the story of the struggle of the English poor against the avarice of priest and king, landlord and capitalist; a story told by the records of thousands of court rolls, and stewards' accounts, compiled by unconscious historians that little dreamed of the tale the figures they so patiently added up would one day be made to tell. From the beginning of the thirteenth century, when almost every one not only possessed land but cultivated it; when a landless man was looked on as an outlaw and a stranger; when the use of the common pasture was without stint, and the arable land of the manor was usually communal; from that remote date to modern times, Prof Rogers conducts the reader through the successive stages of a drama whose motive was the cheapening of labor for the benefit of the monopolist.

APPLETON'S SCHOOL PHYSICS. By Alfred M. Mayer, Ph. D., F. E. Nipher, A. M., S. W. Holman, S. B., F. B. Crocker, E. M., edited by J. D. Quackenbos, M. D. New York: American Book Co. 12mo, pp. 544. Price $1.20.—The reader of a book pre-

pared as this one is by well known specialists in the several departments treated, would be disappointed if the result was a failure. In this instance there could be no disappointment as the work is skilfully done, embodying the latest discoveries and the most recent practical applications of physical science, while much of the apparatus used in the experiments is new, some of it being the invention of the authors. The book is praiseworthy and, with the exception of one or two errors of statement that the editor should have corrected, may be heartily commended as having attained the authors' object in preparing it.

MALARIA AND THE CAUSATION OF INTERMITTENT FEVER.—Dr H. B. Baker. Reprint.

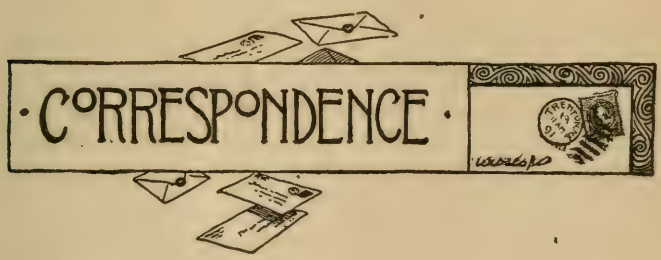
TREATMENT OF CATARRH.—J. J. Stephens, M. D. Reprint.

THE CURE OF CROOKED AND OTHERWISE DEFORMED NOSES.—Dr John B. Roberts. Reprint.

THE RELATIONS OF BACTERIA TO PRACTICAL SURGERY.—Dr John B. Roberts. Reprint.

THE GAP WORM OF FOWLS. H. D. Walker, M. D.—Reprint.

AUSCULTATION AND PERCUSSION. Dr F. C. Shattuck.—Physicians' Leisure Library. Geo. S. Davis: Detroit. Price 25 cents.



EDITOR THE MICROSCOPE:—

In the May issue, in my Reference Tables, I find that under zinc white cement the quantities have been omitted. The German formula should read: 1. Mastic, 10 pts. 2. Dammar, 4 pts. 3. Sandarac, 4 pts. 4. Venetian turpentine, 1 pt. 5. Spts. of turpentine, 20 pts. 6. Benzol, 10 pts. The method of mixing 1, 2, 3 with 4, 5, 6 is correct. The English formula

should read: 1. Gum dammar, 3 pts. 2. Gum mastic, 1 pt. 3. Benzol, 6 pts. Directions for solution, etc., will do.

Yours truly,

ORONO, ME. A. B. AUBERT.

EDITOR THE MICROSCOPE:—

Will some one kindly tell me how I can, in a thorough and clean way, bleach ferns which have been dried a long time, so as to stain, in order to show sporangia, etc.? I have tried solutions of chloride of lime and soda, but they attack the stems long before the fronds, and thus the specimen falls to pieces, besides leaving more or less scum on the fronds. Chlorine gas, as far as I have used it, is more satisfactory, but does not render the sporangia entirely white. The foregoing methods as tried by me take a long time—from several days to a week. I would like a quick, clean and effective bleach, especially suited to take the chlorophyll, etc., from the cells without injury to the specimen. I am many miles from a large city, so that the address of the firm from which any particular chemical can be obtained should be given.

HAVERHILL, N. H. J. D. L.

EDITOR THE MICROSCOPE:—

Some random thoughts of past experience have arisen to the surface by reading on page 372, No. 12, Vol. 10 of THE MICROSCOPE, as follows:

"I started at the end where the most ignorant beginners take the first steps. I now understand how greatly in need of disinterested advice I then was. It would have saved me much groping in the darkness, for the path was through the deep woods, with much stumbling over partly hidden obstacles."

Now, my dear "Amateur," I enter a mild demurrer to your having any regretful recollections of that "path through the deep woods," for it was a valuable and necessary schooling—a part of the microscopical alphabet—which, had it been omitted in your case, the students of the microscope would not now be in possession of much sound, practical advice which they have gleaned from your "Notes on the Microscope Stand and on some of its Accessories."

For years I too was wandering about in the "deep woods,"

with oftimes an aching head and a sad heart, waiting for books, instruments, or a microscopical journal to which I might apply for sound advice. Now, I look upon that "deep woods," or those alphabetic days of microscopy, as my ablest and most valued microscopical schoolmaster, whose teachings have taught me how to appreciate the writings of a teacher who has struggled through the same deep woods, e'en tho' occasionally I demur a little. I can not help but still love the old a, b, cs which sometimes taught me things I had to unlearn in later years; and although this unlearning is a trouble and a difficult task, yet each difficulty being conquered by one's own effort, showers a host of microscopical blessings which are not apparent, or at least heeded, when clothed in the garb of advice, although from good authority and a free gift.

One of the best accessories for the young microscopist to possess is a bull-dog-hang-on-a-tive-ness, and a determination to succeed. The writer worked two years over a frustule of *P. angulatum* before getting a glimpse of striation thereon. Another year was spent in search of "hexagons," but that proved a feat my lens could not accomplish. At this period of learning my a, b, cs I became the possessor of one of those "powerful glasses" with which I could almost see a trace of a small "hexagon!" Right here magnification struck me and suggested that my tube was too short, which, by the aid of a little card-board, was elongated to about eleven inches when lo! I saw some "hexagons." The sight of these must have given me the "big-head" fever, for I wandered through dark, deep woods, looking into that tube till it was elongated to 23 feet!! and showed only *one* hexagon measuring three inches in diameter. This is no Munchausen yarn, for at that time it was earnest a, b, c work, and the 3 in. hexagon was seen; but please do not press me to give my present x, y, z views of its "definition;" suffice it to say it cured me of the magnification mania. These three years' labor in getting a faulty interpretation of the structure of *P. angulatum* was a schooling to me in my a, b, c novitiate, that makes much of the present x, y, z work in modern microscopy sufficiently smooth sailing to compensate for the struggles when in the dark deep woods of a, b, c work.

This experience may seem as an overdrawn picture of doltish ignorance to those who have begun their microscopical studies

at x, y, z, under the advantages of modern instruments and able instructors. If so, let him take the lecturer's stand for a twelve-month tour from Maine to Louisiana, and make each lecture a "free and easy chat all around" with his audience, and he will be plied with questions, even from many teachers and professors of schools and colleges, revealing a darker and deeper microscopical woods than the pathway trod by "Graybeard" in his a, b, c, study of *Pleurosigma angulatum*.

There is a something in the manipulating of a microscope which it seems to be impossible to learn from books; each must work it out for himself, or become imbued with it by some process of absorption or of imbibition, which seems to take place when the novice sees the work done by one who can do it. Verbally, I find it almost impossible to teach the handling of a high angle, adjustable homogeneous immersion objective over test objects, yet the student readily "catches on" after seeing me do it, although he protests that he is unconscious of doing anything in his successful effort other than was done in his unsuccessful ones. The student who struggles through the whole microscopical alphabet from A to izzard, will be better prepared for original work than one depending upon the absorption process of beginning with x, y, z. The first turns out investigators; the second, imitators.

Let the student learn all he can from the brains of others, yet if he does not make his own brain work he will never become a microscopist. After he can show a clear, truthful resolution of *P. angulatum*, I consider he has learned the names of the letters of his manipulative alphabet; he must now combine them into words and sentences. There are other stages to pass;t he era of *A. pellucida*, fine rulings bordering on the phvsical limits of vision, etc., and I may still add another; that of public lectures, especially if conducted on the writer's method of "a free chat all around with his audience." The mirror of which while glaringly reflecting the microscopical ignorance of his audience. will at times form diffraction images on his own brain, making the balance of the lecture evening a sleepless night, either in tossing from side to side on his bed, or bending over his tube till the breakfast gong arouses him to the fact that he is only mortal, be he ever so wise.

NEW ORLEANS, LA. GRAYBEARD.

THE MICROSCOPE.

AN ILLUSTRATED MONTHLY MAGAZINE.

VOL. XI. TRENTON, N. J., SEPTEMBER, 1891. No. 9.

ORIGINAL COMMUNICATIONS

THE HISTOLOGY OF LUMBRICUS, OR THE EARTH-WORM.—II.

HENRY L. OSBORN, PH.D.,
PROFESSOR OF BIOLOGY, HAMLINE UNIVERSITY.

PLATE IV, IN AUGUST NUMBER.

THE pen refuses to represent fully the appearance of a much-magnified section, but Fig. 3 will resemble the section of your own preparation sufficiently to permit identification of the subjects of remark. The section is a picture such as can be found at many places on a series of sections; we may suppose it is a much higher amplification of part of *Set. V*, of Fig. 2. In it we find the structureless cuticle *cu.*, a secretion hardened above the outer ends of the cells in the layer just beneath. The cuticle is not a celluiar membrane. This is shown by its homogeneous character. If it were a layer of cells, their nuclei or traces of them could be seen, and the fact would be still better displayed by surface preparations of the cuticle. Such views show the cuticle, however, to be dotted with minute pores,

whose presence permits the escape of the sticky mucus or slime secreted by the ectoderm cells. The high power applied to vary their sections shows the vertical elements, barely visible under the low power, to be nucleated, cells tall and narrow and standing closely packed. We remember that animal cells are thin, delicate-walled, therefore we do not expect to see the individual cells clearly outlined, but the closely-placed nuclei and the lines which are parallel with them, crossing the layer everywhere, are indications which permit only one interpretation of the shape of the cells: they must be columnar. There are two deviations from this type of cell in the layers of the ectoderm; one is the "goblet cell," seen here and there in any portion of the skin. It is an oval, clear spot, which looks as if it might have been the position of a former cell, now empty and gone. The goblet cell is understood to be a cell of the ectodermal layer, which has been caught at a moment when it is full of mucus, just prior to discharging it through the pores of the cuticle. The other kind of ectoderm cell is that lining the lower portion at least, and perhaps all of the pit in which the seta is lodged. In this position the cells are not columnar, but cubical, as indicated by the shape and relative number and position of the nuclei. The seta is a structureless, blunt bristle, similar chemically and in appearance to the cuticle, and, like it, non-cellular.

The remaining thickness of the skin is chiefly muscular. The individual muscle cells can be best seen in the circular muscle layer, where, in cross-sections like the one we are studying, they are seen lengthwise. The fibre thus displayed is parallel-sided or nearly so—the long, deeply-stained body is its nucleus. The round nuclei scattered about are those of the connective tissue layer, the fibres of which can be seen filling in spaces where the epithelium or muscular tissue may be wanting. The muscular fibres of the longitudinal layer are cut endwise in one section. They are very regularly arranged inside a framework of connective tissue, which gives them a very regular appearance, as shown at *L. mu.*, in Fig. 2. This muscular tissue is somewhat like that which is called involuntary or unstriped muscular tissue in human anatomy; it is the human histology, but is the only kind in *Lumbricus*. Besides the circular and longitudinal muscular layers, there are small muscular fibres, which are

attached to the inner ends of the setæ and run forward and backward. These muscles can pull upon the inner ends of the setæ and tilt them, so that they point either forward or backward; possibly by the combined pull, both at the same time, the seta can be thrust a little further out through the skin.

We have now examined the skin of *Lumbricus*, and a very wonderful structure it is, too; full of thin cells, all of them alive and leading each a life of its own, some of one kind as regards both shape and function, others of other kinds. In *Lumbricus* the skin is very much the same in all parts of the body. In some marine worms we should find a great variety in the skin at different places, and discover in it different sense organs of vision, touch, and perhaps other forms of sensation, and besides these, perhaps gills and other organs. In fact, the skin in *Lumbricus* is about as simple and devoid of variety as it is in any of the segmented or annelid worms.

We shall now turn from the skin, which we have been scanning closely with the high power, and examine the lining of the cavity of the pharynx. As we move the slide about under the high power objective, we see that the wall is continuous. Not at any place do the cells stand apart and place the loose, intercellular spaces where the muscular cells lie in open communication with the cavity of the pharynx. This is like the outer skin. Its cells guard the layers within, never tiring, but watching night and day, to prevent anything passing their line. This is very important to the welfare of an animal, for the living muscular and nervous and other cells which lie within these lines are very delicate and sensitive, and many things in the world without might harm them were it not for this barrier, the skin, which is ever in the way of things that would pass in. Figure 2 shows that the pharynx is lined with two kinds of cells. Figure 4 shows these in greater detail, one kind covering the dorsal portion of the pharynx and found also in the ventral portion, figured at the level of *Ep. nu.*, in the cut. It is not easy really to see the shapes of the cells. You must see rather a number of lines and indications, and these you must interpret. Such a result is now described. The cells of this portion of the pharynx are tall and narrow and covered outwardly with a very strong band of cilia. The nuclei of the cells are not in a single row, but seem to occupy several levels. The inner ends of the

cells are not very distinct; no firm line can be detected there; and it is probable that the cells at the bases are drawn out into processes which become lost among the cells in the muscular coat. In most or all parts of the pharynx where ciliated, columnar cells are found, they stand opposite a second, wholly different type of pharynx-epithelium. The cells of this second layer are *glandular cells;* they show no intercellular boundaries (in my sections), but the shape, size and position of the nuclei show them to be cubes or some closer, resembling form. The glandular and the ciliated layers accompany each other in the upper and lower portions of the pharynx wall, but the side walls of the organ, which nearly meet and connect the dorsal and ventral portion, are purely glandular. The functions of these two kinds of epithelium are, of course, entirely diverse, the ciliated being a locomotive tissue, while the other doubtless helps furnish the abundant mucus, which must be required to reduce friction in the passage of the vast amounts of sand, etc., which must travel the length of the intestine. The muscular portion of the pharynx wall is composed of very numerous fibres, which form an exceedingly thick mass, almost filling the cavities of the aterior somites of the body. These fibres are long threads, enlarged at the position of the elongate nuclei, radiating or directed away from the centre of the organ. They are part of the muscular system which follows the digestive epithelium everywhere, but here they are increased enormously in extent. In some worms the pharynx is further equipped with a muscular apparatus for protruding the organ through the mouth and retracting it, and is further furnished with horny teeth, operated by additional muscles, so that in *Lumbricus* we have again a simpler condition of the organs than is met with in a great many other worms, particularly those living in salt water.

We have now examined only a portion of all the organs of the head region of *Lumbricus*. We have carefully considered the skin and the alimentary tube. We have not examined the segmental organs, the vascular or nervous systems; if we were making a complete survey of the subject these would require attention. They could, however, secure only very inadequate treatment if they were attempted to be noticed in the limits of the present paper.

EXPLANATION OF ABBREVIATIONS IN THE FIGURES.

Ec., Ectodermal portion of skin.
C. mu., Circular muscle layer.
L. mu., Longitudinal muscle layer.
Br., Brain.
Ph., Cavity of pharynx.
C. ts., Connective tissue.
Set. v., Ventral setæ.
Cav., Body cavity.
Seg., Segmental organs.
V. n., Ventral nerve cord.
V. v., Sub-neural blood vessel.
Ep. g., Goblet cell or mucus cell of ectoderm.
Cu., Cuticle.
Ep., Epithelium of pit lodging seta.
Set., Seta.
S. mu., Muscle of seta.
Gl. nu., Nucleus of gland cells.
M. nu., Nucleus of muscle cell.
Ep. nu., Nucleus of ciliated epithelium.
Cil., Cilia of epithelium cells.
M. ph. nu., Nuclei of pharyngeal muscle.

CYTOLOGY OR CELLULAR BIOLOGY.

IX.—THE NUCLEUS AND NUCLEOLUS.

REV. A. M. KIRSCH, C. S. C.

OF all the parts of the cell, the nucleus presents the greatest difficulties to the investigator, not only on account of its minuteness, but even more so on account of its being the seat of that physiological activity, which is closely related to that mysterious force in nature, the activity of which calls into existence new cells and also new individual plants or animals. When Carnoy wrote the following words: "The germinative vesicle is the nucleus of the egg," he seems to say that the study of embryology presupposes the study of the nucleus. Embryology is regarded as the foundation of all knowledge of organized beings, and therefore it becomes at once apparent that the study of the cell-nucleus is at the bottom of all biological science. The study of the nucleus is difficult, and Carnoy, although devoting con-

siderable time towards its study, declares it still a riddle and a mystery. However, this is not so true with regard to its structure and organization, as it is with regard to its physiological activity. Undoubtedly the nucleus must be considered a body *sui generis*, as it were, a cell within a cell, and in a certain sense autonomous to a cell; nevertheless it possesses a structure peculiar to itself and may be considered incapable of living outside a cell. We may distinguish three elements in it: the membrane, the protoplastic portion and the nuclein element.

Structurally, morphologically and physiologically, the nuclear membrane and protoplasm do not differ greatly from the cell-membrane and cell-protoplasm; but in the nucleus we find an element not represented in the general cell-protoplasm, and this is the nuclein tubule. This element always assumes a particular form, so that the older authors spoke of it as the figured bodies of the nucleus.

Before proceeding any further it becomes necessary to decide upon a terminology which we are to use. So far, no terminology has been agreed upon, and in fact the one now existing is, for the most part, misleading, inappropriate and even in some cases nonsensical. With regard to the limiting membrane of the nucleus, it will be sufficient to call it nuclear membrane or wall in contradistinction to the cell-membrane or cell-wall. As already stated, the nucleus has also a protoplastic portion, and this, although derived originally from the cell-protoplasm, and having an analogous structure, nevertheless is distinct, and this difference must be expressed by a properly selected term.

In 1882 Strasburger re-introduced the term cytoplasma, which is very appropriately applied to the cellular protoplasma. Flemming also introduced the cytoplasma in 1882 to replace that hybrid term nucleoplasma, composed of a Latin and a Greek word.

The term caryoplasm is appropriately chosen to represent the nuclear protoplasm, but Flemming did not attach to it the same meaning which Carnoy gave it in 1884. The former uses it to designate the figured bodies or the nuclein; but the latter in the sense of nuclear protoplasm. Although these two terms are strictly speaking not necessary, still they may be used, sometimes to great advantage, one to represent the cellular protoplasm and the other nuclear protoplasm.

At present, the term caryoplasm, or according to others, nucleoplasm, retains no longer its original meaning. In fact, according to Strasburger, caryoplasm is simply the plasma of the nucleus, *i. e.*, the tubule of Carnoy, which Strasburger considers to be filled with nucleo-microsomata. According to Strasburger, therefore, the nucleus would be simply a convolute plasmatic tubule filled with microsomata and surrounded by a membrane, but according to Carnoy the nucleus is composed of a surrounding membrane and a true nuclear protoplasm with its own structure, in which is found a convolute nuclear tubule containing a substance greatly stained by methyl green, and called nuclein. Caryoplasm is therefore true nuclear protoplasm, just as cytoplasm is true cellular protoplasm.

Caryoplasm, like cytoplasm, is a hyaline and apparently homogeneous substance filled with scattered granules; but by examining it more attentively under the microscope, it may be seen to consist of a reticulum and a granular enchylema similar to those structures found in the cytoplasm.

THE NUCLEIN.—This element is found under various shapes and forms. The typical form, however, seems to be that of a continuous and convoluted tubule, wound up somewhat like a ball of yarn; and in this tubule is contained the nuclein proper. As the tubule is convoluted, and therefore crosses itself over and over, in these places it often unites and has the appearance of a real network. The manner in which the tubule is disposed in the nucleus varies greatly. Sometimes the coils or convolutions are chaotic, not unfrequently they are more or less parallel and cross each other at the polar ends, somewhat like longitudinal lines on a terrestrial globe; examples of this kind may be seen in the testicular cells of spiders. When such cells are seen from the polar ends, the tubule appears to be arranged in a radiating manner, but if the focusing is continued downwards, the nuclein appears to be arranged in a circle, and finally the radiate arrangement reappears when the opposite pole comes into focus. There can hardly be any doubt as to the continuity of the nuclein tubule, yet this is not always the case; in fact, previous to caryodieresis, the nuclein tubule always breaks up more or less into shorter or longer pieces.

The reason that for a long time the nuclein was believed to exist in separate pieces, scattered more or less within the nucleus,

is owing to the fact that observers took no account of the optic illusion produced by the microscope. It is a well-known fact in microscopy, that the lens will only show an optic section of the object; but by a comparison I hope to make this matter clearer.

Suppose a thread of yarn is wound up into a loose ball; by making actual sections with a sharp knife the thread would necessarily be cut into small pieces or coils; the same thing apparently takes place with the nuclein filament when optic sections are made by means of the microscope.

I have often directly observed the continuity of the filament by focussing rapidly up or down, so that the image of the previous optic section had not time to be effaced from the retina. The same result I have often obtained by focussing slowly up or down, at the same time following with the eye; the thread appearing without any interruption, it is therefore continuous. Sometimes the appearance of the nuclein in the form of short coils is due to some particular cause. In fact cells from the testicles of the grasshopper, the *Libellula* and *Isopoda* have nuclei in which the nuclein seems to be in the form of short pieces; but this again is so in appearance only, for if the cell be stained first by borax carmine and afterwards by methyl green, that philosopher's stone of nuclein, it may be seen that the nuclein tubule is here and there empty, and consequently the staining with methyl green reveals only the spaces which are filled with nuclein; but the carmine shows that the tubule is continuous.

The diameter of the nuclein tubule varies also, being generally greater in cells derived from glands and smaller in those taken from the testicles. Sometimes the diameter is uniform throughout the whole length, whilst often the tubule becomes enlarged here and there, so as to assume a moniliform appearance. We have already seen that the nuclein element of the nucleus is composed of a tubule in which is contained a more fluid substance the nuclein proper; it is this nuclein which is especially stained with methyl green, so that this agent becomes the real touch stone of nuclein. This tubule never completely disappears; it persists although broken up, during the various karyokinetic movements which it undergoes during cell division. The nuclein exists in the tubule in various forms, sometimes filling it completely, at others forming a layer in the interior against the

wall of the tubule so as to leave an empty central canal, and frequently it even forms regular disks with regular intervals between, so as to give the nuclein tubule a transversely striated appearance, resembling somewhat a striated muscular fibre. Whatever may be the appearance of the nuclein, one fact is brought out by the researches of Carnoy, viz., it is never granular or in the form of microsomata, as is believed by Strasburger and others.

II.—PROTOPLASTIC ELEMENT OF THE NUCLEUS.

The caryoplasm has a structure similar to that of the cytoplasm, *i. e.*, a reticulum of plastin and an enchylema, only the latter is generally more hyaline and the former less pronounced. This protoplastic portion may be seen directly in many nuclei. It may be seen especially in those nuclei in which the nuclein tubule is more loosely packed, or when its convolutions are not too numerous; also when the nuclein is more or less contracted towards the centre so as to form a nucleolo-nucleus, as is the case in cells from *Lithobius*.

Sometimes by cutting sections, the nuclein tubule is dragged out, and then the reticulate structure of the protoplastic portion becomes quite evident.

Space will not allow me to give further evidence of the existence of the protoplastic portion, and therefore I must refer the reader to the work of Carnoy in "La Cellule."

III.—THE NUCLEAR MEMBRANE.

It will be sufficient to state here that the nuclear membrane presents the same organization as the membrane of Von Mohl; it is reticulated, closed and without pores. This, however, is contrary to the ideas of Leydig, Strasburger and Heuser.

IV.—THE NUCLEOLUS.

The existence of a nucleolus within the nucleus can no longer be called into question. To reveal its presence fresh material must be used, and this has to be stained with methyl green, and then the nuclein must be dissolved by one of its dissolvents. In this way the presence of several kinds of nucleoli may be demonstrated. First, we find nuclein-nucleoli, which are little amorphous bits of nuclein, colored by methyl green and dissolved by concentrated hydrochloric acid. Second, plasmatic

nucleoli, which are small albuminoid masses containing plastin, not stained by methyl green, and not dissolved by the dissolvents of nuclein. Third, mixed nucleoli, consisting of both nuclein and albuminoid substances, which however remain separate, as methyl green will stain one portion without affecting the other. Fourth, nucleolo-nuclei or minature nuclei, which are made up of the same elements as the nucleus itself, possessing, therefore, a membrane, a protoplastic portion and a nuclein tubule. Such nucleolo-nuclei may be found in cells of the *Lithobius*. Mixed nucleoli are probably only nucleolo-nuclei devoid of a proper membrane.

THE SHORT SLIDE AS A SAFETY SLIDE.

DR. HENRY SHIMER.

MUCH has been said in microscopical books, journals and elsewhere about care in using high power objectives, and warning of the danger of racking downward, etc. Having to use a fine, high power, dry objective of very short working distance, always nearly or quite touching the cover glass when in focus, it is well known that the thickness of a series of cover glasses of the same number varies greatly; hence, one of a package could be worked through while another could not.

Looking across the stage and carefully racking down until the front of the lens was so close to the cover that I could not see between them with a hand lens, thereupon applying the eye to the eye-piece and manipulating the screw of the fine adjustment, I often found that I was still above the focus, and it became an important consideration as to how close I could press the cover glass with safety and advantage when searching for an object mounted in aqueous or glycerine medium. The little accidental motes when seen moving about in the medium, sounded a note of alarm and said: "You can go no closer; even now there is danger." I have a so-called safety nose-piece in my possession, a contrivance with a spring in it between the tube and the objective, to prevent unbearable pressure, but it is not always on the stand; moreover, it is a troublesome thing in changing objectives where the stand has a short working distance, for it makes quite a long affair to handle and not touch

the cover glass in changing lenses after using a low power as a finder. This safety spring admitted of an unpleasant pressure, sometimes causing the mounting fluid to swell over the cover glass, sometimes getting on to the lens, greatly to my annoyance. At this juncture I looked about me for a better remedy than the safety nose-piece to use in my studies of objects on slides not finished by drying and sealing in a permanent mount. I then began to use the short slide, as presently to be described. It was a new idea to me; whether new or not to other and more experienced workers, I cannot tell, but I do not remember having ever seen it mentioned in any of the microscopical books or journals at my command. I formed, in this way, a preference for slides two inches long and seven-eighths of an inch wide, finally coming down to one and three-quarter inches long and corresponding in length with the excellent short slides furnished by the Bausch & Lomb Optical Co., and very nearly corresponding with the length of the German slides furnished by Zeiss, of Jena, and to be had of Emmerick, in New York. Both of these, however, I found too wide for using as safety slides with my apparatus, the opening in the slide carrier on my No. 560 Bausch & Lomb stand being just an inch wide. I therefore was obliged to get the best, clearest glass I could find, and make my own slides, seven-eighths and three-quarter inches wide by one and three-quarter inches long. A fine file or a piece of scythe whet-stone rubbed over the edges and corners removes any sharpness, and is quickly done. A thousand slides of this kind can easily and quickly be made, and will answer every purpose in ordinary work. By mounting the object in one end, I have a safety slide.

Place the slide so that the mounted end, when projecting over the opening in the stage, is free in air. Now it is apparent that when thus placed under the close-working objective, it cannot be injured, because, when the point of the objective presses on the cover glass ever so slightly, it can make no more than this slight pressure, for the slide, being placed see-saw-like over the opening, will begin the dip of the see-saw motion and tell me that closer racking is useless. In this way I avoid the great care that is necessary in using the old three-inch or long slide with the mount in the middle. This is without the least possible danger of injury to either the mount or the objective, while that

is not. This is my first plea for the short slide. Such safety can hardly be furnished by any other device, and certainly no other is so free from annoying care.

Second. The short slide is more conveniently stored in a horizontal till, which is preferable to sliding in the sawed grooves, and just as easily handled by the free end when we are accustomed to it.

Third. The short slide is less likely to be broken if it accidentally falls on a hard floor, the liability to break increasing as the square of the length, or more rapidly. A slide an inch long would hardly break once in a thousand falls, while one a foot long would most surely break at the first.

Fourth. The short slide is lighter and more conveniently packed for transportation, which is important especially in the mails.

Fifth. The short slide costs less, an item of some importance to many of us.

There are some objections to the short slide. The principal ones are as follows:

First. It is not the standard slide. It is not the fashion, and to be out of fashion is a great load for many to bear.

Second. The long slide may be better adapted to work on the turn-table, which is a great convenience where a cell is to be made; still, the circular cell can be made on the end of the slide with a suitable turn-table. A square cell can readily and more quickly be made by hand, and a square cover can be cemented around the border more quickly than the slide can be placed on the turn-table, and the square cover is better for most purposes, except for glycerine mounting, now nearly out of credit, and perhaps for dry mounting.

Third. The long slide has some claims of moment in manipulating on the stage, in case we have no slide carrier; but why be without a slide carrier? If I had none I would at once improvise one with a thin piece of cigar box lid, pasteboard, tin, or a long piece of glass, five or six inches long, the former, of course, with a hole cut in the middle. I have tried microscopes formerly without slide carriers, but after using one for fifteen years with a slide carrier, I would almost as soon think of being without a microscope as to be without this first and greatest convenience in manipulating the slide on the stage.

If the opening in my slide carrier were one and one-eighth inches wide, as it ought to be, I would probably use all slides one and three-quarter inches by one inch, such as those sold by the Bausch & Lomb Optical Co., but, as it is, I have been obliged, for some time past, to work against another prejudice, and use narrower slides, and I find a slide three-quarters or seven-eighths of an inch wide ample for most uses, and for all covers, three-eighths to three-quarters of an inch square, and is sufficient for the label; so what more do we want? If it is more labeling room, the two sides of the free end of the short slide can be used, thus affording plenty of space for the purpose.

The labels which I prefer for the purpose I cut out of gummed paper, in slips one-quarter to one-half an inch wide, and two to two and one-quarter inches long, as needed. Moisten and apply around the free end of the slide; after drying, write the name and number on the upper surface, and the mounting medium date and stain on the lower. In this way I find room for everything on the short slide.

I have heard it objected that the label under the slide places the latter out of level on the stage. This, at first sight, appears true, at least theoretically. But let us see how fine a theory it is. The thickness of a sheet of my gummed paper, measured by a micrometer, is about the one-thousandth of an inch, determined by holding the paper edgewise in a stage forceps, under the microscope. In case we are using a power of 500 diameters, the field will be about one one-hundredth of an inch across. Now, by proportion, the length of the slide is to the diameter of the field as the thickness of the label is to the inclination of the field, or x. Then, $1\frac{3}{4}$ in. : $\frac{1}{100}$ in. : : $\frac{1}{1000}$ in. : x; $\frac{7}{4}$ x = $\frac{1}{100000}$; x = $\frac{1}{175000}$ of an inch, for the variation from a theoretical true level, or in the breadth of vision with a one-fifth or one-sixth objective; and if we are using a two-inch, one-tenth of that, which is $\frac{1}{17500}$, is out of level, on account of the label on the under side of one end. Where is the instrument maker, however skillful, who can construct a stand the tubes of which shall vary so little as that from a true perpendicular to the stage. The best slides may vary more than that in the thickness of ends. Stands that raise one side of the stage, by the fine adjustment, as do some of the Acme stands of J. W. Queen & Co., disregard this principle in a very much larger de-

gree without detriment. This is my plea for the short slide. Will the reader allow me to submit it for its worth, without expecting to see its general adoption, but hoping to help someone who, like myself, is often bothered about the close working objectives, that in spite of all carefullness, occasionally impinge upon the cover glass. Racking downward is very troublesome to old eyes using high powers. They find it difficult to look across the stage to reach below the focus, where the looking distance is one one-hundredth inch or less. Let all such try my safety slide, and they will find its perfect working convenience an ample compensation for being out of fashion or for lack of imaginary beauty, and after using it often and long, and trying it faithfully and well, they will, like myself, never wish to see another long slide for ordinary microscopical work.

REFERENCE TABLES FOR MICROSCOPICAL WORK.

IV.—ANILINE STAINS.

COMPILED BY PROFESSOR A. B. AUBERT.

ALUM EOSIN: Eosin, 1 part; alum, 1 part; alcohol, 200 parts. Reagent for hæmoglobin. Specimens previously treated with osmic acid $\frac{1}{2}$ per cent for 3 minutes. Wash thoroughly before staining.

ANILINE BLUE, (water solution): Aniline blue, 0.02 grms.; water, 25 c. c.; alcohol, 25 to 30 drops. Specimens hardened in alcohol.

ANILINE BLACK: Aniline black, 0.5 grms.; alcohol, 99 c. c.; water, 1 to 2 c. c. Stains in a few minutes; for brain, etc.

BISMARCK BROWN: 1. Concentrated aqueous solution, warm, or weak alcoholic solution. 2. Bismarck brown, 1 part; water, 3,000 to 5,000 parts. For protoplasm, connective tissue, bacteria, living organisms, etc. Material to be hardened in alcohol or chromic acid; wash in absolute alcohol. Mount in glycerine or balsam.

BORAX METHYLIN BLUE: Concentrated aqueous solution of blue, 24 vols.; borax solution, 5 per cent, 16 vols.; water, 40 vols. Dissolve; filter after 24 hours.

CHINOLIN BLUE: Aqueous solution, 1-100,000 to 1-500,000. For living organisms (water analysis), etc.

DAHLIA OR HOFFMAN'S VIOLET: Glacial acetic acid, 12.5 c. c.; absolute alcohol, 50 c. c.; water, 100 c. c.; dahlia nearly to saturation. For axis cylinder of nerves, protoplasm, nucleus. Stains in 12 hours or less.

EOSIN: Water solution, or water solution and one-third of alcohol; or eosin, 1 part, and water 1,000 to 1,500 parts. For epithelium, muscle, axis cylinder, amyloid degeneration, nucleus, etc. Stains in $\frac{1}{2}$ to 1 minute or more.

GENTIAN VIOLET: Filtered 3 per cent. aniline solution in water; concentrated gentian violet solution in alcohol; or gentian violet, 2.00; ammonia, 0.5; absolute alcohol, 10. For bacteria, etc. At ordinary temperature stains in about 24 hours; 1 hour at 50° C. Treat objects with 30 per cent. hydrochloric acid, dehydrate in absolute alcohol, clear in oil of cloves, mount in balsam.

IODINE GREEN: Iodine green, 0.1 part; water or alcohol, 35 parts. Stains in a moment. Mount in balsam.

FUCHSIN (ROSANILIN): Fuchsin, 0.25 grms.; alcohol, 20 c. c.; water, 20 c. c. For nucleus, protoplasm, axis cylinder, elastic tissue, retina, etc.; after staining, treat with alcohol.

FUCHSIN (acid): Concentrated solution in water. For nervous system. Sections hardened in chromic salts. Keep in stain one hour, wash with water, put into alcoholic solution of potash (potash, 1 grm.; alcohol, 100 c. c.; filter after twenty-four hours; use 10 c. c. diluted with 100 c. c. of alcohol); wash in water, dehydrate in alcohol (saturated with salt), mount in balsam.

METHYLIN BLUE: 1. Erlich's concentrated water solution. 2 Koch's concentrated alcoholic solution: Methyl blue, 10; caustic potash (10 per cent. 0.2; water 200). 1 and 2 for bacteria, cover glass preparations; stains in one-half to twenty-four hours; wash in water, dry, mount in balsam. For tubercle bacillus; after staining in blue, transfer cover to concentrated solution of vesuvin (15 minutes), wash well in water, dehydrate in alcohol, clear in oil of cloves (micrococcus brown; bacillus blue).

METHYL VIOLET: Methyl violet concentrated alcoholic solution, 11 c. c.; absolute alcohol, 10 c. c.; aniline water, 100 c. c. For bacteria, etc.; cover glass preparations; stains in 24 hours; put cover for a few seconds in nitric acid and 3 parts water; wash with alcohol; stain with diluted vesuvin solution for a

few minutes, wash in 60 per cent. alcohol, dehydrate in absolute alcohol, clear in oil of cedar, mount in balsam.

METHYL GREEN: Water solution, 2½ per cent. Nucleus, nerves, amyloid substance (degenerated tissue violet, normal green). Stains in 24 hours.

SAFRANIN: 1. Safranin, 1 part; absolute alcohol, 100 parts; water, 200 parts. 2. Water, 1 part; alcohol, 1 part; safranin, as much as will dissolve. For nucleus; washed sections stain in a few minutes; wash and dehydrate in absolute alcohol, mount in dammar or balsam. Water solution (1–1200) for bone development (bone, connective tissue, red; cartilage, yellow). Wash with water slightly acid with acetic acid.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XX.

THIN GLASS—CONTINUED.

The glass varies in thickness from one-fiftieth to one two-hundredth inch or less, and is designated by number, the thickest bearing the highest. No. 1 varies from one one-hundred-and-fiftieth to one two-hundredth inch in thickness; No. 2 from one one-hundredth to one one-hundred and fiftieth, and No. 3 from one fiftieth to one one-hundredth inch, the price increasing as the thickness diminishes. The thickest, or No. 3, is seldom used for anything but opaque objects to be studied with low powers. I should advise the reader not to use it for any purpose unless it be to make cells. For covers it would better be avoided. Objects covered with No. 1 glass may be examined as well by low as by high powers, and thus subserve a double purpose. The thinner is the more difficult to use and to clean, but it is better to employ it than to find the objective hampered in its action because the preparator supposed that no part of the specimen was worth examining with a higher power than the one-inch. Another advantage in the use of the thinnest glass is that it less injuriously affects the optical performance of the objective.

The circular disks as well as the squares vary in size. The former may be had from three-sixteenths to seven-eighths inch or more in diameter, and the squares from one-half to one inch. The smallest circles are useful for mounting a single minute object, such, for instance, as a single Diatom, but for ordinary use five-eighths inch in diameter is a good size. Few permanent mounts are made with squares, but for temporary purposes, where the object is studied but not kept, or where it is living and moving, a large square is the most useful and convenient form for the cover glass. Its corners project beyond the margins of the cement or other kind of cell enclosing the object, so that as the water evaporates it may be easily supplied by adding a drop at one corner, when it will gently flow under by capillary attraction. There is no objection to the permanent mounting of a slide with a square cover glass, except that a circle looks better, and since the cell is usually circular, a circular cover fits it better and the finishing cement may be more neatly and expeditiously applied at the margin. For sections of some large object, or for a number of sections to be mounted in regular sequence as cut by the microtome, squares or oblong pieces are much more desirable than the circles, and are pretty generally used for this purpose by microscopists. The optician will cut them to order, if desired.

The thin sheets of glass, so brittle that they break almost at a word or a look, are cut with a diamond. The circles are made by placing on the glass plate pierced with holes somewhat larger than the disks desired, and a diamond is then run around inside these openings until the entire surface of the glass sheet is covered with the scratched circles. To attempt to break these out would be followed by disastrous consequences, but if the glass be laid aside for a day or two, the disks will fall out of their own accord. The squares are cut with a diamond and a ruler, after the thin sheet has been attached by water to a flat surface, usually of plate glass. After the cutting the squares are easily broken off by sliding the sheet to the edge of the support.

As the covers come from the dealers, they are usually in any but a clean condition. The surface is commonly obscured by the results of the handling to which the glass is necessarily subjected, and this greasy portion must be entirely removed before the cover can be used. Some microscopists soak their

glass in sulphuric acid for a short time, adding water carefully, so as not to generate suddenly too much heat. When the liquid is nearly neutral, the vessel is placed under the hydrant and a stream sent among the covers. They are then left in the water until the owner is ready to take them out and wipe them dry. This troublesome process is seldom necessary, and, indeed, the use of sulphuric or of other strong mineral acid, would better be avoided by the novice unless he knows something of chemistry. Cleaning may be accomplished by gently wiping the glass with a soft cloth, the cover being held between the thumb and finger of the left hand, while the thumb and finger of the right apply the cloth to both surfaces at once. Considerable skill and practice are required to do this successfully, for the glass is very thin and very brittle, but after a few attempts covers will seldom be broken. The cloth should be carefully kept smooth, so as to avoid the irregular pressure of wrinkles.

Several mechanical cleaning devices have been described, but nothing is better than two smooth wooden blocks, each with a surface tightly and smoothly covered with soft, thick chamois skin. The cover is placed on one block while the other rubs its surface until it is clean, when the whole is turned over, and the other block rubs the other side of the glass. With this simple contrivance it is hardly possible to break the thinnest cover.

After being cleaned the glass should be kept clean, as well as free from scratches. It is exposed to the latter if thrown loosely into a box, where a particle of hard dust may do mischief. Mr. C. E. Hanaman, of Troy, N. Y., has described a method of keeping the covers protected from accident and dirt. He places them in drawers or boxes filled with narrow strips of new white blotting paper, between which they are stood on edge. This method, Mr. Hanaman says, not only preserves the covers from breakage and enables him readily to pick them out when wanted for use, but also assists him to select for special preparations those of the most desirable thickness, for, by holding the drawer or box between the eye and the light, it is easy to select the thickest or the thinnest.

The glass varies a good deal in thickness even in the same lot as supplied by the optician. Its thickness may be most conveniently measured by some sort of micrometer gauge, of which there are several in the market for the use of machinists. Dr

Carl Zeiss makes one especially for the microscopists, but either of the three manufactured in this country, especially that of Bausch and Lomb, will answer equally well. It is not only convenient but important to have covers of different thicknesses sorted out, so that almost any kind may be had at a moment's notice, and the micrometer gauge is slightly more accurate in its results than the fine adjustment screw, with which the thickness may also be estimated. An experiment made while writing gives the thickness of a cover as measured by a gauge to be one two-hundreth inch, while the fine adjustment screw gives 0.0045, or about 1.223 inch.

To use the former, place the cover between the jaws of the instrument, close them and read the thickness in hundredths and thousandths of an inch. To use the fine adjustment screw for the purpose, if the milled head be graduated and the value of the spaces known, it is only necessary to count the number of divisions employed in focussing from one surface of the glass to the other. A few particles of dust will answer as objects on which to focus, or a minute drop of ink on each side of the cover, and so close as to be together in the field of a high power objective, but not close enough to overtop each other. In the experiment referred to, the number of the divisions on the milled head used in focussing from the lower to the upper surface of the cover, where four and one-half, and as each division corresponds to a movement of the body tube of one one-thousandth inch, the cover was four and one-half thousandths, or 1-223 inch thick.

The most desirable as well as the cheapest and the best micrometer gauge now in the market is made by Messrs. Bausch and Lomb. This was described by its inventor, Mr. Edward Bausch, in THE MICROSCOPE for October, 1890. To that paper the reader is referred.

EDITOR'S DEPARTMENT

THOSE not specially interested in the structure of protoplasm would do well, for the present, to omit this department of the magazine. They have been warned in time.

According to Heitzmann, Klein and several German observers, animal protoplasm is a network of fibrils radiating in all directions through the cell and containing a homogeneous fluid within its meshes. This and other inclosures have been referred to in an admirable manner by Professor Kirsch in his valuable series on Cytology; but a sight of this reticulation within the cell is one that has been most desirable for every microscopist, but that to the amateur has been especially difficult. The appearance of the structure has been repeatedly figured, but the sight of a picture is not to be compared in satisfaction to the sight, although it may be an imperfect one, of the actual object itself. This has heretofore not been an easy task, but through no discovery of my own it has recently come to my knowledge that there is a common animal in whose intestinal cells this structure of the protoplasm may be observed with comparative ease and with lively satisfaction. The animal is the common pill-bug of popular language, the *Oniscus murarius* of the naturalist, who classifies it among the Crustacea. It is found in abundance under damp boards and decaying wood in moist places. In order to see the appearances as described by certain observers, I sought the *Oniscus*, and in five minutes had gathered a dozen. It seems to have received its popular name from its habit of bending itself into a pill-like form when disturbed and touched. A pupil of my acquaintance once carried several pill-like specimens to his teacher as a new and large variety of seed.

Kill an *Oniscus* by a few drops of alcohol. Remove the legs to get them out of the way. With fine-bladed scissors slit up the body on the lower or abdominal side. Push away, or carefully remove, the walls of that part of the body, and the intestine will be in plain sight. It is a nearly straight, tubular ves-

sel, large for the size of the animal, and usually gorged with food, or its remains. It is a conspicuous object and may be readily removed. After removal it must be slit open, so that the inner surface shall lie upward toward the objective. To do this, my plan is with great care to insert a fine needle into the lumen, the cavity of the intestine, and when the tube has been placed on the steel without having its wall pierced at any point, it is gently rubbed with another needle until it is slit from end to end. This is not a difficult thing to do if the needles be fine and the microscopist's hand be steady. After the intestine, or a part of it, has been taken from the body, all subsequent manipulations may and should be performed on the slide and in the cell in which it is to be mounted.

The intestine, slit open, is then placed in a small drop of water, and while it still remains attached to the needle, is to be gently freed by another needle and floated in the water, inside upward. The intestinal contents are then to be washed away by the repeated dropping of water. When thoroughly cleaned, as may be known by the disappearance of all the brownish fæces, drain off the water and add one or two drops of a solution of methyl green, one of the aniline stains to be had of the dealers in microscopical supplies. The dye acts rapidly, so that from four to five minutes will usually be long enough to color the parts sufficiently. Wash away the superfluous stain, drain off the water, add a drop of diluted glycerine and apply the cover glass, cementing it in place with shellac.

A small piece of the intestine is all that is needed; it is not necessary to take the entire intestinal tube. I have found the rectum, the posterior region nearest the external aperture, to be free from fæcal matter, and beautifully transparent. In this part, too, the cells may be rather better displayed than in the anterior regions.

The cells are comparatively immense, with conspicuous cell walls, prominent nuclei with their enclosed nucleoli, and with the structure of the protoplasm finely displayed. The latter may be seen well with a good 1–5 inch objective, but of course with greater satisfaction under a lens of higher power. A close, small meshed network of the protoplasm does not seem to be a constant and invariable feature of its structure, although in many cells it is exquisitely demonstrable, while in many others

it is composed of exceedingly fine fibres radiating in every direction from the centre toward the cell wall and forming meshes so narrow that they are very inconspicuous, really demanding somewhat careful search to see them. Here the fibrillated structure dominates, and this appearance calls to mind the aspect of an almanac sun, the face of the symbol being here represented by the somewhat irregular nucleus, and with the fine rays increased to an indefinite number.

While examining these large and beautiful cells, the observer should bear in mind these two appearances, and not be disturbed if the network is not as plainly visible and the meshes as close, small and regular as he expected they would be. In my experience the fibrils are the most readily demonstrated, unless a very high power, a 1–12 or higher, be used to study the protoplasm surrounding the tubule of the nucleus and situated between it and the membrane enclosing the nucleus and separating it from the protoplasmic contents of the cell. In this part of the object the reticulum, or network of delicate fibres, is superbly demonstrable.

Those that have been reading Professor Kirsch's papers on Cytology have learned that the nucleus, while it appears to be formed of a reticulation or network, is in reality composed of a single fine tubule much convoluted upon itself, the apparent network being produced by the crossing of the tubule over its preceding convolutions. The nucleus is in structure only a single, very much twisted tube, whose hollow is filled with a substance that has been named the nuclein. In the intestinal cells of *Oniscus* beautiful optical sections of this are obtainable, since the nuclein takes the stain with great avidity. The network is here conspicuous and the meshes, unlike those of the protoplasm of the cell, are fine and small. Altogether, therefore, the intestinal cells of this common animal cannot be excelled as objects in which to examine the structure of the protoplasm, a subject that is always interesting and should be seen and understood by every microscopist.

ACKNOWLEDGMENT—To Dr. W. N. Beggs, St. Louis, for a superb preparation of pigeon's blood preserved by the osmic acid method and mounted in glycerine. Dr. Beggs is one of the most accomplished and expert preparers of histological

mounts in this or in any other country. His work is perfect, and the microscopist so fortunate as to possess any of his slides is to be congratulated. In the treatment of the blood of various animals his methods seem to be especially successful. The results are at least all that can be desired.

NEWS · FROM · THE · WORKERS ·

IRIDESCENT GLASS.—A visitor at the Metropolitan Museum of Art in New York cannot fail to notice in his tour of the galleries the exquisite ancient Cyprian glass ware, with its gorgeous iridescence surpassing in brilliancy of color anything ever produced by artificial means. So far as is at present known, this effect can be produced only by the corrosive action of the air and moisture of the soil in which these objects have been buried for centuries.

Glass having a similar appearance, but without the same brilliancy of color, has been found elsewhere, and a certain degree of iridescence has been imparted to glass of modern manufacture by flashing it during the annealing process with stannous chloride, thus depositing on the glass an exceedingly thin film, which decomposes the light and thus yields a pleasing color effect. Glassware of this kind is beautiful, and was at one time much in demand, but at present it can hardly be found on sale.

Through the courtesy of General L. P. Di Cesnola, director of the Metropolitan Museum of Art, the writer has been enabled to examine specimens of ancient Cyprian glass secured by him in his archæological explorations in Cyprus.

A microscopical examination of this glass shows that the surface is covered with exceedingly thin transparent films formed by matter dissolved from the glass. The body of the glass is pitted over its entire surface with minute cavities, which are circular or elliptical or oblong in outline, and either spherical, ellipsoidal, or cylindrical in respect to their concavity, and the films conform to the pitted surface of the glass. These films, of

which there are many superposed, are so thin as to float in air like down when detached. They decompose the light by interference due to reflections from the front and rear surfaces of the film and give rise to the gorgeous play of color for which these ancient specimens of glass are noted. By transmitted light the color is complementary to that shown by reflected light. Examined by polarized light, the color is heightened still more with all the changes that may be brought about by rotating the polarizer, analyzer, or the object itself.

If the effects secured by long ages of treatment in Nature's laboratory could be produced artificially on modern glass at a reasonable cost, it would seem to be an object well worth striving for.—*Prof. George M. Hopkins in Scientific American.*

AN INSTRUMENT, called the *hæmatokrit*, has been lately invented by Herr von Hedin; it is for determining the volume of corpuscles present in blood, and is based on centrifugal action. A volume of blood and one of Möller's liquid (which prevents coagulation) are mixed together, and the mixture is brought into small thick-walled glass tubes, graduated in 50 parts. The tubes rest on a brass holder which is fixed on the axis of a rotation-apparatus. After some 8,000 rotations, in 5 to 7 minutes, the process is complete. The separation between the corpuscles and the salt-plasma is more distinct, in that a narrow band of leucocytes appears between them. The instrument is useful in comparing the blood of different individuals. With a little practice, the total error is not more than one volume per cent.—*Nature.*

A NEW CULTURE FLUID.—Dr. G. M. Sternberg gives the *Medical News* a short note, interesting to laboratory workers and others, on the use of the fluid contained in unripe cocoanuts as a culture medium. This fluid, unlike that of the ripe nut, is devoid of all milky appearance and is perfectly transparent. By the people of the West Indies it is known as agua coco, or cocoanut water, and is very popular as a refreshing drink; at the railway stations and restaurants may be seen piles of the unripe nuts, which at a moment's notice can be broken open and made to yield a tumblerful of the fluid at a trifling cost. The cocoanut is a germ-proof

receptacle, and, if care is taken in the removal of its fluid, the latter requires no sterilization at the time of its reception into the bacteriologist's tubes or flasks. Dr. Sternberg has been able to store it away almost indefinitely for future use, the fluid remaining perfectly transparent and ready for immediate use. Heating the fluid will cause in it a slight precipitate. He has employed this medium quite extensively during the past two years, although he has been cognizant of some of its properties since 1879, and has found it of great convenience. Certain micro-organisms multiply in it more rapidly than others in consequence of its slightly acid reaction when first obtained from the nut. This reaction makes it unsuitable for cultures of certain of the pathogenic bacteria, but, when desired, it is a simple matter to neutralize it. A detailed chemical analysis of the fluid is given in the paper.—*New York Medical Journal.*

BALSAM MOUNTING.

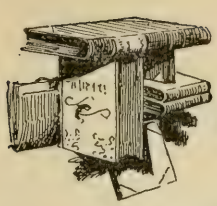
V. A. LATHAM, F. R. M. S.

IN reading through the January number of THE MICROSCOPE I noticed the article on mounting. Cajeput oil is not new to me, as I have used it for several years, also oil of bergamot and several other oils; the last which I am now working on is Turpenol or Turbenol (Merck). The reason I first tried the oil of cajeput was the difficulty to mount neatly and evenly sections of human skin and tracheæ, for they curl up when placed in alcohol. This oil is better than clove oil for this purpose, but unfortunately alcohol has to be used, though the process is simplified by using it diluted.

I hardly know of the specimens for which I have been compelled to use absolute alcohol, the ordinary spirit being sufficient. In England where methylated spirit is the chief dehydrater used on account of cheapness, then you may require to use the absolute alcohol. The only cases in which I have used

the last have been where I was making cover glass specimens of bacteria, and was in a hurry for them to dry so that I could mount at once. Neither is it, I believe, used in the University of Michigan in the Histological Department. I find my mounts perfect, even those stained with anilines after some four years, and in a paper written in one of the journals of microscopy I casually mentioned it with some other clarifying agents. Turpentine and creosote are used by many to get over the difficulty of strong alcohol; these are very good, but personally I object to the penetrating odors. I would like to say that I think a great deal of difficulty is made over mounting in balsam, which in reality never or seldom exists. True, each method is not nearly so difficult on practically demonstrating as by reading. I give you the method I have always employed for myself and also for teaching, with success so far. Have a mounting card made so that you can use it to centre the slip. In the centre of the slide place a medium-sized drop (the second which falls off the rod is about the size); carefully spread the balsam over the surface not quite to the edge of the cover (when it may have been placed in position). Lift the object from the clove oil, drain off most of the oil, except in such sections as lung, brain, etc., and transfer it to the slide in such a way that it is in the centre when mounted, and do not draw the lifter beyond the ring, or the medium runs a little outside the cover and makes an untidy mount. See that the section has no folds, then take a clean cover glass in the forceps and near the edge of it let fall a drop of balsam; invert the cover and place the point of a needle on the slip at about the place where the edge of the cover is to be when mounted; place the edge of the cover glass against the needle and gently lower it till the drops meet and flow evenly; when the balsam gets to about the middle of the specimen slowly draw away the forceps almost parallel to the slip and the cover is then in place, with few if any air bubbles under it. Do not press down the cover with a needle or weight, for unless you have a quantity of superfluous balsam it is not necessary; put the slip away in a warm place in a tray or cabinet, perfectly flat, and in drying the balsam contracts and draws down the cover to the specimen. I often ring slides at once with Hollis's glue, even sending them by post 200 to 500 miles without the least harm. The two essentials are to learn the amount and thinness of the balsam, and not

to leave too much clove oil on the lifter. Drying of objects in ovens, etc., seems to me a nuisance, except in cases of mounts without pressure, and even here I do not advocate it. The formula that I use for balsam may be useful, as it is colorless when mounted and is easily made; otherwise the Palmer Slide Co.'s balsam is the whitest that I have bought of late years, and is a quick drying medium, more so than the one I use. In fact, I am anxious to find some solvent which will evaporate faster, and yet, if possible, at the same time, to avoid much contraction. Obtain a white sample of balsam in liquid form and take by weight in all cases, in a wide-mouthed bottle, balsam, 3 ounces; turpentine, 1 ounce; chloroform (pure), 1 ounce; gently turn the bottle several times to mix well and let it stand till free from air bubbles and is thoroughly mixed. Pour out a small quantity at a time in a one dram bottle, and keep it covered with a cork, with a glass rod drawn to a point passed through it, or take a piece of glass rod and heat till soft, and press the two ends together so as to produce a flange. It is then easily wiped and cleaned with a rag moistened in turpentine. Care is taken to lower the cover very slowly. As a question, may I ask if any one who has been to Europe and returned here with specimens, has noticed how the climate causes great shrinkage to balsam mounts? As an instance, I have mounts of Cole's Studies, and special mounts of his, and I find now that the zinc white has let air pass through and has ruined the mounts; in many cases I have had to remount them. I may say here that I am not in favor of the usual white zinc cement, and recommend either brown varnish (Ward's, Manchester, Eng.), or Hollis's glue. The last is the best, for it may be used with immersion lenses, and it renders ringing unnecessary afterwards, which is a bug bear if you should be in a hurry to examine a specimen, which is often the case in medical work.



NEW PUBLICATIONS

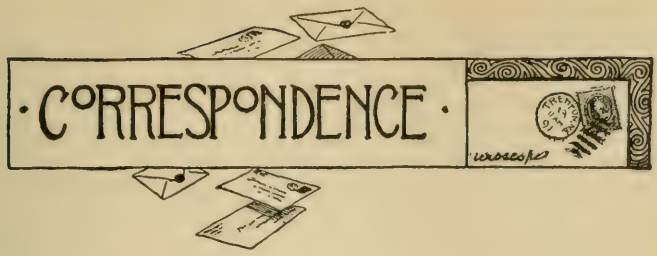
TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE, 1889. 8 vo., pp. 189. Topeka.—The paper by V. N. Kellogg on the Mallophaga, the bird-lice, merits special attention, since these parasites have received but little notice by entomologists and microscopists. The author gives an analytical table of the genera which must prove very useful to students.

REPORT OF THE EXAMINATION BY MEANS OF THE MICROSCOPE OF THE SPECIMENS OF INFUSORIAL EARTHS OF THE PACIFIC COAST OF THE UNITED STATES. By Dr. A. M. Edwards. 8vo., pp. 29. Newark, N. J.: The Author.—Dr. Edwards has studied diatomaceous deposits from Puget Sound to the southernmost borders of California, and in this pamphlet embodies his conclusions as to their origin, gives lists of the forms found in the various localities, and enters quite extensively into the geology of the subject. In reference to the origin of the Diatoms, he says: "Some experiments that I am making would seem to point to the fact that the Diatomaceæ originated in fresh water and were carried down to brackish water and so on to the sea. Brackish forms, as *Nitzschia scalaris*, E., have been seen growing in great profusion in a fresh water pond without any outlet, and brackish forms . . . have been grown in fresh water. The concentration of fresh water in the Western lakes, as at Lake Bonneville and Lake Lahontan, have resulted in brackish water." The type setting and press work were done by the author.

CONSTITUTION AND BY-LAWS OF THE NORTHWESTERN MICROSCOPICAL SOCIETY, St. Paul, Minn.

ELECTRICITY—ITS APPLICATION IN MEDICINE. Dr. Wellington Adams. Sq., 16mo., 2 vols., pp. 113, 129. Detroit: Geo. S. Davis. Price, 50 cents.

BUL. OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY.



EDITOR THE MICROSCOPE :—

Your July editorial on "Travelling Stands" inspires some further suggestions coming from experience. For several years I had one of those largest imposing "first-class stands" and two or three kinds of pocket microscopes. After making this investment I became acquainted with the late Dr. Joseph Leidy, whose unsurpassed work on the Rhizopods was then in process, with the aid of a microscopical outfit not worth fifty dollars. His obvious wisdom in respect to apparatus made me ashamed of my extravagance. I sold the imposing stand and invested again in a way to gain the double advantage of a travelling stand which also serves all practical needs for work at home. For the past seven years I have used in this double capacity the Griffith Club microscope only and deem it the *vade mecum par excellence.* Its compactness is a triumph of ingenuity, and it unfolds for more varied uses than any other stand I have seen.

Why does it not supply the need as you describe, and not merely that, but all other uses for a stand? For vacation use, the heavy turn-table foot, which gives this stand such a steady base at home, may be omitted. Thus the whole weight of stand and case is reduced to four pounds. All your requisites named cannot be combined much lighter.

Instead of the foot, a pedestal is furnished, having a screw at its lower end, by which the stand may be fastened to a stump or log. In camp, a stake may be driven in the ground, inside the tent, and the pedestal screwed to the top of the stake, to which may also be fastened the lamp attachment of the microscope.

At home, for my working purposes, the pedestal is screwed in to the edge of my table. Thus the microscope is conveniently at hand, yet out of the way of my work, and so secure

that it may not be upset. The heavy foot of the stand removed and set on a steel point, makes an admirable turn-table, its weight giving it such momentum that, with one impulse, it revolves for a long time. Clips, usually so objectionable, are not so on this stand, being fixed to a bar, acted on by springs, so that they may be turned back, leaving the stage clear. Screws adjust the springs to regulate pressure on the slides.

The glass stage is ample for all conceivable use, and being round gives a better opportunity to manipulate the slides than if square.

The fine adjustment is admirable in its action and not open to the objection of most other methods in which the action runs out, requiring readjustment.

The draw tube arrangement makes it suited to the long English or short German notions. The sub-stage ring enables the use of needed accessories, the Wenham parabola, Abbe condenser and the Polariscope. The ring removed, one may have extreme oblique illumination. The swinging and extension mirror bar affords various methods of illumination above and below the stage.

The easy portability of the stand serves my purpose in every way. I rarely fail to take it to the meetings of our Illinois State Microscopical Society, where it has been peculiarly useful. With its ingenious lamp attachment, it may be handed around among the members for the examination of slides illustrating the subject under consideration. No other stand is so serviceable in this respect; hence, it has been to our meetings many times more than any other kind. I regret the fact that it is often the only one there, which may be because it is always expected and best serves every purpose.

As to its expense, so much merit cannot be afforded at the cost of the cheapest stands; but in view of its versatility, and that it is all any practical microscopist needs, it is an economical investment.

I have been impelled to write this partly because "Amateur," in his Encyclopedia of American Microscopes, has ignored the existence of this stand, which was surprising, in that the Griffith is peculiarly the exponent of most of the merits he has praised in other stands, and so far as I can now recall, has none of the demerits which he condemned.

This communication is only intended to do some justice to a stand which did not deserve to be omitted in the general "round-up."

"Amateur's" praise of Mr. Bulloch's stands especially was richly deserved. As a friend of Mr. Bullock, I have been much pleased that the great merits of his stands received such recognition.

CHICAGO. B. F. QUIMBY.

EDITOR THE MICROSCOPE :—

It may be interesting to microscopists to know of a Diatom deposit in Mississippi, which has not, as yet, to my knowledge, been noticed. It is south of Jackson, and I presume in the same Geological horizon as the beds near Montgomery, Ala., mentioned in your columns some time ago. I have not visited the locality myself, and my discovery of it was almost accidental. I had a pupil who showed me some "polishing earth." That was some years ago, before I owned a microscope. Last Winter something brought Diatoms and polishing powder into close juxtaposition in my mind I believe it was an article in THE MICROSCOPE. I wrote to my former pupil to send me a sample, and when I examined it my guess was verified. The material is very poor, in perfect forms, the valves being very much broken. I have noted one species of *Surirella* and several of *Navicula*. I have not compared it with Electro-silicon, but it is certainly a success as a polishing powder.

HOUSTON, MISS. E. L. SHERWOOD.

ITEMS

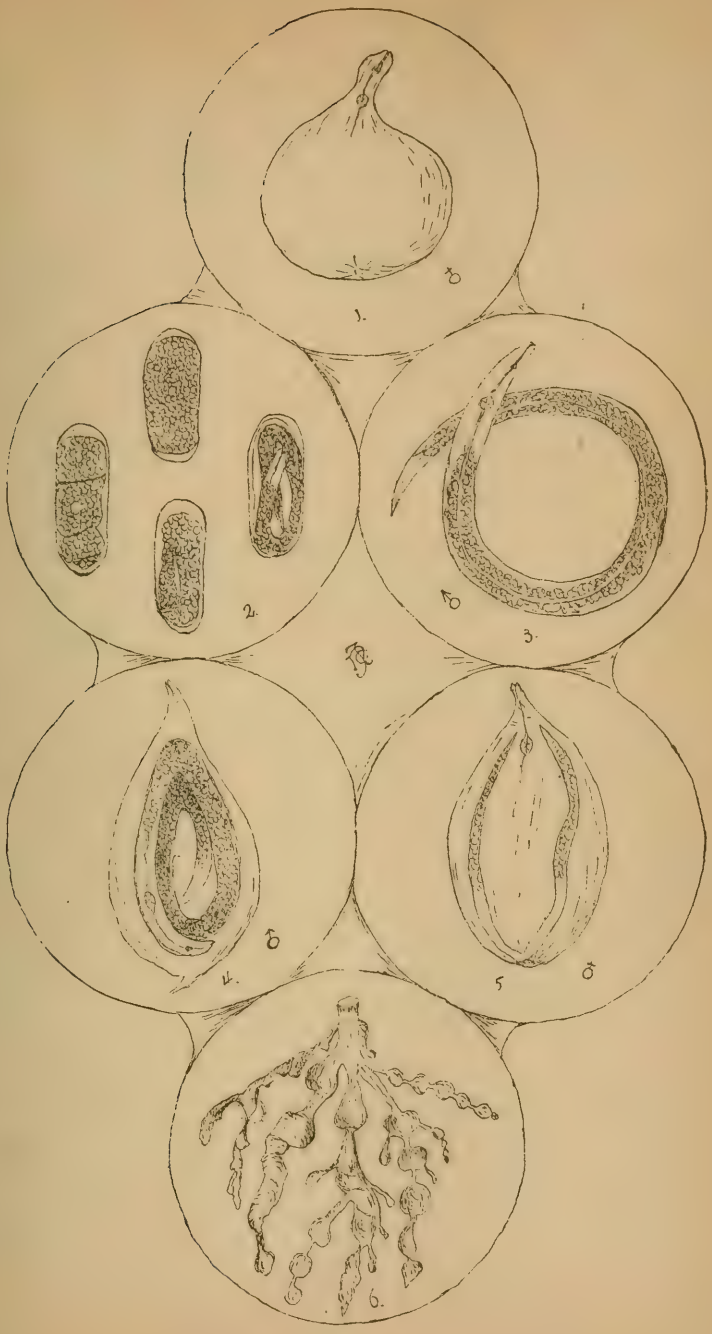
Mr. Tuffen West, the microscopical draughtsman, died in England, recently, at the age of sixty-eight. He was unrivaled as a draughtsman and a manipulator, and his love for his subject supplied him with never-failing energy. It was not, however, solely for his artistic ability that his collaboration was eagerly sought by authors, for it was well known that he was both able and willing to give help in the most varied directions

of scientific and pathological research. Work by others, which had passed through his hands, not only obtained very considerable security against error, but not infrequently received important additions and elucidations. His good nature in these matters was occasionally somewhat imposed upon, and papers and books were published which really owed quite as much to the man whose name appeared only as artist as they did to him who assumed the role of author. In a general way, he rendered these services with pleasure and because he delighted in his work, but there were instances of this kind of partnership which he felt to be unfair, and concerning which he would remark, with a smile, "My poverty, not my will, consents." Nothing that he undertook was ever scamped. Thus it follows that few original papers are to be credited to his pen. His work stands chiefly in other men's names. A paper on the mechanism of the feet of insects was of his own contributions to science, the one in which he took most pride. Four years of his life were devoted to the illustrations of Blackwell's volumes on English spiders and five to those of Smith on Diatomaceæ.—*Jour. R. Micros. Soc.*

Mr. John Mayall, Jr., died in London, July 27th, 1891. He was a prominent and distinguished student of the principles of the microscope and one of the secretaries of the Royal Microscopical Society.

There is nothing among the recent disclosures of the microscope in regard to the rocks so surprising as their delicate adjustment to their environment. We are accustomed to look upon the masses of our mountains as the very type of what is stationary and eternal; but in reality they are vast chemical laboratories, full of activity and constant change. With every alteration of external conditions or environment, what was a stable equilibrium for atoms or molecules ceases to be. Old unions are constantly being broken down and new ones formed. Life in our planet, like life in ourselves, rests fundamentally in chemical changes. Such processes as these, which properly represent the physiology of our earth's crust, have long been suspected, but their exact nature and details are now being gradually disclosed by microscopical students of the rocks.—*Popular Science Monthly.*

PLATE V.



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ORIGINAL COMMUNICATIONS

THE ROOT-GALL NEMATODE.

JAS. C. NEAL, PH. C., M. D., ENTOMOLOGIST AND BOTANIST, FLA. EXP. STATION.

(WITH PLATE V.)

THE nematode, which may or may not be *Tylenchus arenarius or Heterodera radicicola*, is the cause of a mysterious disease of the roots of many of our field crops, nearly all our vegetables and some of our finest fruit trees, and is particularly destructive to "truck-patches" in the Southern States. Recently it has caused much anxiety in Australia, where it has been investigated by Dr. Cobb.

The study of this worm requires an outlay of skill and patience that, to put it mildly, is prodigious, and, were it not of such vast importance to our agricultural interests to follow up its life history, in the hope of discovering a method to alleviate its ravages, very few microscopists would spend time upon so illusive a subject.

As a pioneer in this vexatious business, I venture to describe some of my mistakes and successes, hoping others will avoid the first and surpass the last, aided by my brief sketch.

These nematodes are easily found in the "knots," or better called "galls," upon the roots of the bean, pea, tomato, celery, parsnip, beet, turnip, okra, egg-plant, radish, cucumber, melon, squash, peanut, cotton, Irish potato, clematis, colias, dahlia, amaranth, weeping-willow, English walnut, fig, plum, peach, &c., as well as upon the roots of weeds, like Pursley, Jerusalem oak, tea-weed (*Sida*), careless weed (*Amarantus spinosa and retroflexus*), poke weed, coffee weed, &c. I give this partial list for the benefit of our Southern microscopists, that I especially hope will give it their attention.

Let the experimenter visit a truck-patch or field of Pindars (*Arachis*), and if he can find plants of the tomato that look as if withered by sudden heat, or Pindar stalks with stunted growth, pull them up, and see if the roots are not knotty, abnormally enlarged, with softening spots, or with the bark of the root decayed so as to slip easily. The appearance of the nodulated roots is characteristic, often like strings of beads in the smaller roots of celery, okra and cotton, or like rapidly-decaying fungoid growths on the willow and cow pea (*Dolichos catiana*). Figure 6 shows a cow pea root, from nature.

Breaking open one of the larger galls of the cow pea or tomato, the gravid worms are easily visible—especially if the gall be discolored by decay—as minute, pearly white, flask-shaped bodies, occasionally attaining the diameter of five millimetres. Carefully picking them out with a fine needle (one with a flattened and blunt point is best) and transferring them to a slide with a drop of water, a low power easily shows the mature female, the snaky head and enormous body, as shown in figure 1.

Scraping the diseased tissues with a blunt-edged knife, adding a few drops of water and filtering through coarse flannel into a deep watch-glass, will get rid of most of the vegetable tissues, and in a few moments the eggs, immature and male worms will settle at the bottom, and a drop of this sediment, obtained with a pipette, will show on a slide most or all of the forms given in figures 2, 3, 4, 5.

By boiling the galls found on Irish potato, dahlia, coleus, willow and radish, and making sections, fine specimens for

mounting can sometimes be obtained; or soaking the roots of parsnip, okra, turnip, radish, &c., in a dilute solution of bichromate of potash (Müller's solution) for a day or so prior to making sections, will toughen the tissues and give better results. I found that while dilute alcohol hardened the worms, so they were easy to manage, it caused a perceptible shrinkage and distortion, which Müller's fluid did not.

In practice, it will be advantageous to keep a quantity of roots of okra, cow pea and the like in water. They will soon decay enough to permit separation of the tissues, and the task of finding specimens will be much easier than in fresh roots.

To mount these fragile and elusive worms requires infinite tact, and if the student succeeds one time in fifty he is to be congratulated. I found this method, on the whole, the most successful: Build up a shallow cell with gold size, till it is six to eight millimetres in depth, let it dry till slightly "tacky." With a fine needle detach a small portion of the decaying tissue around the gravid, visible worms; add barely a drop of water on the slide, and tease apart the fragment with needles, so as to cover thinly the cell; add either the gum and glycerine or gelatin glycerine to nearly fill the cell, avoid bubbles, apply the cover-glass and press it into the "tacky" border; wipe off the superfluous medium, let it dry for an hour or so, and finish with a varnish or Brunswick black. Sounds easy, does it not, yet how many the slips!

In a gold size cell, a drop of the "sediment" previously referred to, with an equal quantity of glycerine, occasionally gives a good mount, and for short periods a little of the sediment with a drop of "carbolated water," two per cent. solution, does very well. For temporary use, a drop of the sediment, diluted with clear water on a slide without a cover, may show a fine specimen, using a low power, say one inch objective; then by careful manipulation it may be isolated from extraneous matter, the moisture absorbed by blotting paper, a small quantity of medium as glycerine jelly cautiously placed around the object, a drop placed on a clean cover-glass, which is turned over on the slide, and all gently warmed till it flows together. A few bubbles, more or less, ought not to count, for it is nearly impossible to avoid them. Use a fine camel-hair brush with warmed jelly to surround the object, let it cool before further action.

If care is taken, specimens on a slide with a cover can be secured in water, by a dextrous use of gold size or varnish, using a soft brush and the turn table.

To cultivate these nematodes, express and filter the juice of the food-plant in which they are found, to a drop of this in a concave centred glass slide, or a "life cell," place a mature gravid worm, cover with thin glass, examine daily the changes that take place, and every three or four days supply fresh fluid, and you can see all the varied changes, the rapid segmentation of the egg—figure 2—the differentiation of the male and female —figures 4 and 5—the castings of the skin, and the magic breaking, and the final change in the egg from a closed tube to a rapidly moving worm.

There are many things yet for our microscopists to discover. How these nematodes penetrate tissues, how they copulate, why the "gall" is formed, the effect of various poisons available as protective remedies, the amount of heat and cold they can endure, and a complete list of plants they do not attack, especially of trees and plants valuable as "stocks" for grafting or budding, or that can be used in "starving out" infected fields.

These worms, as Dr. Cobb well says, are near the limit of microscopic study and will tax one's gift of continuance severely, but I know of nothing that offers such a remunerative field.

CYTOLOGY OR CELLULAR BIOLOGY.

X.—CYTODIERESIS OR CELL-DIVISION.

REV. A. M. KIRSCH, C. S. C.

THUS far we have studied the cell in its static condition, but in this concluding article it is my intention to give the reader some idea of the cell in its dynamic state. We have seen the remarkable structure of the nucleus and protoplasm when in the state of rest, but during the activity, resulting in cell division, these structures undergo radical and fundamental changes.

Before entering upon the study of this difficult subject, it is necessary for us to fix the meaning of the terms used; and let me state at once that with certain authors the creation of new technical terms seems to be the main object. Why should science be burdened with a number of unnecessary terms?

Some authors have used a technical word for every stage or phase in cell-division, and Carnoy is careful to avoid every such term, contenting himself with stating that cell-division takes place by constriction or by a cell-plate or by both at the same time; and the various stages or phases of these different modes of division are simply described without giving to each a special technical term. For this he has been severly criticised by Flemming, who seems to have a great attachment for technical terms. Every one to his own taste; but I believe most scientists will prefer common words, as long as they are adequate and to the point. I am not opposed to the use of technical terms when they are necessary; but when they become a burden and often a hindrance to the progress of science, they are not only unnecessary but positively injurious. In order to be more explicit, I will introduce the common words which Carnoy uses, with the technical terms which he proposes for those who prefer to use them.

Division	Dieresis.
Cell-division	Cytodieresis.
Nuclear-division	Karyodieresis.
Plasmatic-division	Plasmodieresis.
Kinetic-division	Kinesis.
Akinetic-division	Stenosis.
Kinetic nuclear division	Karyokinesis.
Akinetic nuclear division	Karyostenosis.
Kinectic plasmatic division	Plasmokinesis.
Akinetic plasmatic division	Plasmostenosis.

In justice, I must say that not all of these terms have been introduced by Carnoy, but they are somewhat familiar to American scientists as they have been used by some of our authors; Flemming's terms have not been used, at least, not to my knowledge; for kinesis he uses mitosis, and we therefore would have to speak of mitotic movements in the nucleus, whilst the expression "kinetic movements" is more familiar to an English ear.

The following terms are those used by Carnoy to represent the various stages of cell-division:

1. Breaking up of the nuclear tubule.
2. Equatorial crown.
3. Polar movements.
4. Polar crowns.
5. Reconstitution of the nucleus.

While Flemming uses the following terms:

1. Spirem.
2. Aster.
3. Metakinesis.
4. Dyaster.
5. Dispirem.

I shall not pronounce upon the lucidity of these terms, but will leave that to the reader's judgment; if he is unable to come to a conclusion, I refer him to Prof. Charles Sedwick Minot, of Boston, who writes thus in "Science," Aug. 6th, 1886: "During the division of cells, in the majority of cases, very remarkable changes occur in the arrangement of the chromatine, leading to the development of those striking appearances known as karyokinetic figures, or, as Flemming would like to have them called, mitosis. It is difficult to refrain from styling the latter term, new-fangled; for the systematic duplication of terms with which Professor Flemming has unnecessarily burdened science of late, can only be condemned. It is curious to encounter such pedantry in so industrious and sensible a histologist, because to overvalue terminology is the mark of mental poverty."

It is to be hoped that the progress of science will no longer be hindered by a cumbersome technical language. Technical terms have to be used sometimes, but an unnecessary accumulation of such terms is positively injurious to the advance of real science. Carnoy has been sharply criticised by Flemming for not using technical terms in his memoirs on "Cytodieresis of Animals." Carnoy uses language which is intelligible even to the ordinary reader. It is certainly an injustice to the genius of any language to introduce foreign words, when that language possesses words adequate to express the author's meaning. The three memoirs by Carnoy on Cell-Division will remain classical for a long time. He is not content with studying this phenomenon of cell life in one or in even a few cases, but he has explored the whole branch of Arthropoda in his first memoir, and in the second he treats of the cell-division of the egg of *Ascaris megalocephala*, and in the third that of the egg of some nematode worms. He has carefully guarded against basing his conclusions upon one or on a few cases, but his observations have been made upon all orders of insects; Orthoptera, Coleoptera, Lepidoptera, Pseudo-neuroptera, Diptera, Neuroptera, Hemiptera; upon spi-

ders, myriapods, crustaceans, etc. Before Carnoy, this class of animals had never been studied with reference to cell-division, and what led him to choose this group, he tells on his first page. "Large cells," he says, "of a remarkable beauty, and of an incomparable perfection, young and without inclavata, with gigantic nuclei, even sometimes visible to the naked eye, . . . with membranes that rival those of plant cells—this alone would be sufficient to fix the attention of any cytologist. . . . The Arthropods alone are sufficient to write cellular anatomy."

There are many, even among our best microscopists, who imagine that the study of cytology is unapproachable to any one but the professionals. Let the reader be convinced at once that this is a false impression, and the sooner it is dispelled from the minds of amateurs, the better it will be for science.

There are two kinds of cell-division. The first is by simple fission or constriction of the nucleus and protoplasm; this has been called, by Flemming, direct division; Carnoy proposes the term, akinetic-division, or simple stenosis. In this mode, there are no apparent movements in the nucleus or protoplasm, and it may take place by simple constriction or by means of a cell-plate, similar to that observed in plants. Carnoy seems to have been the first to call attention to this second mode, and this is a further proof of the identity of animal and vegetable cells.

The second kind of cell-division, is called, by Flemming, indirect; Carnoy calls it kinetic, *i. e.*, following certain movements in the nucleus. This kind of cell-division is effected in the following way: When the nucleus becomes active, in its preparation for division, the nuclein tubule contracts and becomes shorter and thicker; next it breaks up into a number of short pieces (rodlets), which are curved or undulate or rarely straight. Thus far no movement has taken place either in the nucleus or protoplasm. After this, the nuclein rodlets begin to move towards the equatorial line and soon are arranged in two rows, forming an equatorial crown. Now the nucleus becomes slightly elongated, and at the same time the cell protoplasm enters into activity—the asters are formed in it and the reticulum soon is seen arranging itself in radiating lines from them. After this the nuclein rodlets move towards the asters; the nuclein membrane disappears, the nuclein forms the polar crowns and the nuclear protoplasm assumes the well-known spindle-shape. At

last, the constriction takes place at the equator, or a cell-plate forms there, and the polar crowns are soon changed into the two new nuclei of the two cells as the result of the division.

Thus we see there are two phases in each processs of division. The first goes as far as the formation of the equatorial crown, the culminating point of kinetic division; this is called prophase by Strasburger. The second phase comprises the dislocation of the equatorial crown and the reconstitution of the two nuclei; it includes the metaphase and anaphase of Strasburger. There is no need of applying new and technical terms to these different processes as Flemming has done, but common language is sufficient for the purpose.

From what I have said, I conclude that cytodieresis comprises both caryodieresis and plasmodieresis; *i. e.*, the division of the nucleus and that of the cell-protoplasm, and that both are effected by certain movements which result in certain kinetic figures, familiar to every student of Cytology.

Space does not allow me to enter into details, but I hope to be able to publish soon in the pages of THE MICROSCOPE some special observations which may be easily repeated by even the amateur microscopist, who thus may gain a fair knowledge of that most difficult problem of Cytology—cell-division.

Here I must thank my readers for the patient hearing they have given me. I cannot flatter myself that I have added anything new to science, but it will be a satisfaction to me if I have opened only a pathway in this department of scientific research for some of the readers of THE MICROSCOPE.

(THE END.)

EMBEDDING AND SECTIONING MATURE SEEDS.

W. W. ROWLEE.

READ BEFORE THE AMERICAN SOCIETY OF MICROSCOPISTS.

THE modifications that may be made of the paraffin method of embedding objects for sectioning are very many. There is always some danger, however, of shrinking delicate and very soft plant tissue. This is due to the use of heat in the process of infiltration; and, probably, some of the non-heat-employing

methods will be found preferable where such delicate tissue is to be embedded. But for objects that will withstand this process of infiltration, the paraffin method has many advantages over other methods. Embedded in paraffin, objects are held firmly and may be preserved as long as desired without further attention.

For embedding mature seeds, I have found nothing that was equal to paraffin. The texture of the seed is often very dense and offers much resistance to a knife. For this reason I found it better to use the harder grade of paraffin. A second serious difficulty that was met with in embedding seeds was the fact that there was little if any tissue connecting the embryo * with the seed coats. Thus it would often happen that just as the sections were being taken through the middle of the seed (the most valuable ones are those near the centre), the embryo would leave the coats and the whole series be spoiled. The inner surface of the inner coat in many seeds is highly polished, and as soon as there is nothing to retain the embryo but its adhesion to the coat it will loosen. The paraffin does not seem to hold the two together as might be expected. It was suggested that in order to soften the tissue, and thereby make it more susceptible of infiltration, it would be well thoroughly to soak the seeds in water before hardening in alcohol. This was tried, and there was a great improvement in the result. Fewer of the sections went to pieces after they were transferred to the slide, and the parts kept their respective positions much better.

In order to study the microscopic structure of seeds, much more satisfactory results can be obtained if the sections are kept in series. It is often necessary to have two or more successive sections before a correct idea can be obtained.

The method used is a modification of the one used and taught in the histological laboratories of Cornell University. In its practical application it is as follows: In choosing seeds to section great care is taken to get those which are well filled. This precaution is especially important, as many seeds never develop more than the coats of the enveloping ovary layers. If a seed

* The term "embryo" is used here, where on some accounts it would be better to use the word nucleus. The embryo is often but a very small part of the substance contained within the seed coats. If the word nucleus is used it might be confused with the histological significance of the term.

has a straight embryo, or even a bent one, it is better to determine by dissection just how its parts are arranged with reference to the external parts or form of the seed. Thus the seeds of *Helianthus tuberosus* are flattened and slightly wedge-shaped. The embryo within is straight, and the upper or inner surface of the cotyledons lie in a plane parallel to the place in which the seed is flattened. Moreover, the cotyledons are in the broader, upper end of the seed. Where the seed has no external character, as in *Eupatorium*, by which the position of its internal parts may be located, one has either to take the chances of getting the section in the right plane, or open the coats enough to see how the parts are arranged, and then mark the seed in some way. Having selected well-filled seed, I put them in water at the ordinary temperature of the laboratory for thirty-six hours. From the water they are transferred immediately to weak alcohol (40 per cent.), and gradually hardened by transferring to stronger alcohol until they are in 95-per-cent. alcohol. Next, they are transferred to equal parts of alcohol and chloroform for from four to eight hours, the time depending on the size of the seed. Then, in pure chloroform for the same length of time. Then, for twenty-four hours, into chloroform with as much paraffin as it will dissolve at the ordinary temperature. From this into paraffin softened with chloroform until the melting point is about 95° Fahrenheit. The specimens are kept in this melted paraffin twenty-four hours. I have always been careful not to let the temperature go above 116° Fahrenheit, although I think it probable that a somewhat higher temperature would not hurt the tissue of the seed. From this they may be embedded in hard paraffin, and will be found thoroughly infiltrated.

They may be sectioned in the paraffin blocks either freehand or with a microtome. It is highly essential that the sections be kept in series, and that none of them should be missing. The texture of a seed is so fragile, than when cut in thin sections the least carelessness may spoil the result.

A very effectual way to keep sections intact when they are cut in a paraffin block is that proposed by Dr. Mark (*American Naturalist*, 1885, page 628). It consists in collodionizing the object as the sections are taken. Very thin collodion should be used and applied to the cut surface after each section is taken. Lee (*Vade Mecum*, page 150) recommends that "the collodion

be of such a consistency that when applied to the surface of paraffin it will dry in two or three seconds. This has no tendency to cause the sections to roll. As soon as the collodion is dry, . . . cut the section, withdraw the knife, and pass the collodionized brush over the newly-cut surface of paraffin." The section is placed collodion side down on the slide. The sections are fastened by placing a little clove oil collodion on the slide and placing them in it, and evaporating the clove oil. They are placed on the slide in series and in definite order, and are then washed in xylol for ten minutes or more. This removes the paraffin. Then they are washed in alcohol, afterwards with water, and stained. I have found no stain as good as hæmatoxylin for this work. They should be stained with it for from three to five minutes. After the washing with water, dehydrate with alcohol, and clear. Three parts turpentine and two parts carbolic acid make a very good clearing mixture. Canada balsam dissolved in xylol is used for mounting.

In sections thus prepared, one can distinguish without difficulty in shepherd's purse, golden rod, or any endospermous seed, the coats, the plumule, composed, as is the lower tip of the radicle, of small thin-walled cells, bearing nuclei. These two regions of growth are connected by slightly elongated cells which are also thin walled. The larger cells making up the tissue of the cotyledons are stored with food. In many seeds a trace of a vascular system may also be seen; also the peculiar arrangement and markings of the cells composing the coats.

Seeds differ so much that one would need to make many variations in method to suit special cases, but as a general plan I have found this to be a success, and I believe the histology of any seed may be demonstrated by it.

THE OBJECTIVE AS A SUB-STAGE CONDENSER.

PROF. WM. LIGHTON.

SOME time ago I carried on a series of experiments in illuminating microscopic objects when using high power objectives, and was greatly interested in one which yielded a remarkably crisp and vigorous image of the object under examination. My object was mounted between two very thin cover glasses,

then attached in the well known way to a wooden slip with a central hole of sufficient size. This mode of mounting made it possible for me to use a homogeneous immersion objective as a sub-stage condenser, as I did.

The objective in use on the tube of the microscope was a $\frac{1}{12}$ homogeneous immersion, 1.30 N. A., the condenser was a fine $\frac{1}{6}$ homogeneous immersion objective, 1.29 N. A., attached to the lower thin glass by homogeneous immersion fluid. The image of the narrow edge of the lamp flame was carefully focussed on the object by the condenser.

I took direct light from the lamp and was as careful to place it at the proper distance from the condenser—ten inches—as I was to adjust the tube length of my microscope.

The condenser was very carefully centred, and gave a cone of light as free from spherical and chromatic aberration as I think can be obtained. I used the entire cone, and also used small stops for central and oblique light. Small dark stops to cover the central portion of the condenser were used.

All modes of use gave an image in the eye-piece far in advance of that obtained by the Abbe condenser—and I have a good one—as the enormous spherical aberration of the Abbe instrument renders it impossible to obtain an exact focus of the source of light upon the object.

I am well aware that a condenser of the kind I used will not come into popular use at the present price of homogeneous objectives, but the object of the present paper is to call attention to the importance of having sub-stage condensers properly corrected for exact focus, and to the careful adjustment of the condenser when put upon the sub-stage. I have seen owners of fine objectives put their condenser, it seemed to me, almost anywhere below the stage and be perfectly satisfied with the result. Of course their objectives were not doing their best work with this treatment.

Some of the world's famous opticians are now furnishing achromatic condensers of from 1.0 N. A. to 1.40 N. A., with corrections almost as perfect as in their superb objectives, and of proper focal power. Of course I would not advise the use of a combination for condenser of as high a power as a $\frac{1}{6}$ objective; a $\frac{1}{2}$ to $\frac{1}{3}$ inch would be much better.

NOTES OF THE MEETING OF THE AMERICAN MICROSCOPICAL SOCIETY.

PROF. W. H. SEAMAN, SECRETARY.

THE Fourteenth Annual Meeting of the American Society of Microscopists began at ten o'clock Tuesday morning, August 11th, in the medical department of Columbian University, Washington, D. C.

After prayer by the Rev. R. S. L. Wood, a very interesting address of welcome was delivered by Dr. John S. Billings, Surgeon U. S. A. In this address the speaker reviewed the microscopical work of the Army Medical Museum and the part performed by Dr. Woodward in developing the art of photomicrography, and by accurate criticism assisting in improving the construction of the microscope itself. The address will be published in full in the Proceedings. The rest of the morning session was occupied in listening to the reports of the secretary, of the committees on constitution, medico-legal microscopy and Columbian Exposition, and in considering the question of incorporating the Society. The last was decided in the affirmative, and a committee was appointed, which later reported a plan that was adopted, and the Society was duly incorporated according to the laws of the District of Columbia. It seems especially suitable for a society which is national in its character to be incorporated under the laws of the national capital at its first meeting in that city. The Society has now for the first time a legal existence, with the power to hold property, and the step will, it is believed, tend to increase its usefulness. The name caused some discussion, which was settled by adopting the title of "The American Microscopical Society," which a large majority preferred to the old name.

The afternoon sessions of Tuesday, Wednesday and Thursday were devoted to visiting the Geological Survey, the Department of Agriculture, including the Bureau of Animal Industry, and the museum and library of the Surgeon General's office. These visits took the place of the working session, and enabled the members to see a large amount of microscopical work done in the best manner and with the best appliances.

The first paper read on Wednesday morning was on "The Microscope in Government Work," by J. Melvin Lamb, M. D.,

of Washington, D. C. This was to a considerable extent explanatory of the things, microscopical, that our visitors were expected to see. It is pretty generally known that Washington is a centre of scientific work, but probably very few people outside of the city know that over eight hundred names are on the rolls of the different scientific societies of the city and that among these investigators the use of the microscope holds a prominent place. Among the objects in the Army Medical Museum of particular interest to lovers of this instrument, are two cases containing specimens of microscopes illustrating the progressive improvement in its construction from the earliest efforts to the present time. A few of these are models constructed to order, but many of them are the actual instruments that were used. The work now being done in the museum consists largely in the production of a complete series of sections of the human embryo, illustrating the progressive growth of each month by a complete set. Many of these slides must necessarily be of large size, and to do this work properly a very large section cutter has been procured.

The Bureau of Animal Industry is just moving its quarters from the old inconvenient rooms under the roof of the old department building to a new home all for itself, in which bacteriological investigation will be carried on with a thoroughness not to be excelled anywhere. The transfer being incomplete, all of the rooms were not in working order, but enough was seen to convey a clear idea of the way the work is done.

In the Geological Survey the principal microscopical business is the preparation and examination of rock sections by the microscope. The grinding of the sections is usually a tedious operation, but several men are here employed, with the aid of a small steam engine, and the work is done with comparative rapidity. Several of the assistants in this department have worked with Rosenbusch, especially Mr J. S. Miller, and one of them, Mr Iddings, has translated Rosenbusch's principal work, under the name of "The Microscopical Physiography of Minerals and Rocks," and which is now our best text book on this subject in English.

On Tuesday evening, Dr Frank L. James, of St. Louis, the President, delivered the annual address in the parlor of the First Congregational Church, which the trustees kindly granted

for that purpose. It may be remembered that the thermometer just at that time was on a spree, and its lofty aspirations tended to make our audience and the attendance generally much smaller than would otherwise have been the case. The subject of the address was, "The Investigation of Scorches and Burns in Textile Fabrics," giving a report of an actual case, in which the work of an expert with the microscope completely altered the appearance of the evidence in a criminal suit, and saved a man's life. The address was deeply interesting to all who heard it.

A very ingenious apparatus for the purpose of showing a large number of slides without the presence of a skilled operator was exhibited and described by Dr. James M. Flint. There were two forms, one in which the slides were placed on a horizontally revolving wheel, by turning which they were brought successively under the objective, and the other in which the slides were arranged on an endless band, which by appropriate devices was dragged over the stage. Either kind was well adapted for museum or class work, for teaching, in schools, etc., and one of them had been some time in actual use. Dr. Thomas Taylor remarked that he had, independently, hit upon a similar device, but a little differently constructed, which also was exhibited before the close of the meeting.

"Comparison of the Epithelium of the Mouth in Necturus and Diemyctelus." This paper by Prof. and Mrs. Gage was illustrated by numerous excellent drawings by the latter, showing the changes in the forms of epithelium in the different parts of the oral cavity of the lizards referred to.

The paper by Prof W. H. Seaman on the "Phosphorescent Organs of Fire Flies" was also illustrated by drawings of these glands to the structure of which little or no attention seems to have been paid by native observers, notwithstanding the abundance of material. The speaker noticed the exhaustive monograph of Prof Dubois on the *Pyrophorus noctiluca* of Brazil, whose light was sufficient to read or study by, and described the very small loss of energy in the production of light by this insect, which was possessed of a method far more economical for the production of light than any we yet know, since a very small part of the energy is changed into either heat or electricity.

On Thursday evening the usual soiree was held in the armory

of the Light Battery and Cavalry Troop, which was largely attended, and very much enjoyed by the visitors. Mr E. H. Griffith was elected to take charge of the working session next year, and Prof Gage of Cornell was also selected by the nominating committee by special vote to make the necessary arrangements and have charge of the working session at the Columbian Exposition.

Twenty-eight papers were offered to the society, several of which had to be read by title, owing to want of time to read them in full. Committees were appointed to consider and report on the steps necessary to be taken to secure uniformity in the screw threads of our objectives, without reference to the taps now in use, made by the Royal Society, as its co-operation could not be secured; also to consider and report upon the possibility of publishing or otherwise securing for general circulation a journal which shall present a review of current microscopical literature, so that the humblest worker in the most remote corner of the United States may, by the aid of such a journal, have at his hands the substance of the world's work in microscopy. The city of Washington offers particular advantages for such an enterprise, because here are taken all the scientific periodicals of the world, the contents of which are freely accessible to any one who chooses to make use of them.

Dr. M. D. Ewell, of Chicago, was elected President for the next year.

Fifty-three new members were elected, a number above the average, representing every part of our great country.

On Saturday morning the members remaining in the city went to Mt. Vernon on an excursion tendered them by the Microscopical Society of Washington. The day was a delightful one, and the pilgrimage to this celebrated place closed a meeting that, while not large in numbers, may be regarded as an agreeable and a successful one.

HOW DO DIATOMS SEE?

DR A. M. EDWARDS.

LAST Summer, while making gatherings on the meadows of Newark, N. J., I came upon a collection of *Colletonema eximium.* Of course this is not a *Colletonema* now, it being

considered a *Pleurosigma*. But that does not matter. What I want to ask is, How do the Diatoms see? They have no eyes or nerves in fact. Are they animals or vegetables? I watched these for some time, and this I saw: A *Colletonema eximium* had a tube broken off in such a manner that it could come out, which it did. It came trembling out until it was all out but about one-eighth. Then it went back again. This it repeated several times. At last it came out entirely, until it was four or five times its length away from the tube. It pointed crosswise to the tube, and I thought it would sail away. But soon it turned about, and without feeling for the entrance of the tube pushed its way back, and seemed to wait as if it were tired. After a time it again came out, and sailed away six or eight times its length, and then it went back into the tube and remained there. Now how could it see its way into the tube without eyes? It sailed straight back without feeling around. When it came out it stretched the tube, seeming to push its way until it was nearly out, and then, with a sudden bound, it squeezed past the opening and shot its way into the world. This I saw more than twice.

NOTES ON THE MICROSCOPE STAND AND ON SOME OF ITS ACCESSORIES.

AN AMATEUR.

XXI.

THIN GLASS—CONTINUED.

THE *Journal of the Royal Microscopical Society* reports from Dr S. Czapski the following method of determining the thickness of cover-glasses of mounted preparations, a measurement which it is often very important to know for high powers. The procedure pre-supposes the possession of some cover glasses, the thickness of which is known, and that the head of the fine adjustment screw is divided by radial lines.

The upper and lower surfaces are focussed with central illumination, and the amount of turn given to the fine adjustment screw noted for each cover glass, it being unimportant whether the exact value of the screw turn is known or not. If the surfaces of the cover glass do not present any obvious marks to focus on, an artificial one, such as dust or scratches,

must be supplied. If the numbers thus obtained be compared with the known real thickness of the covers, a reduction factor is obtained from their quotients, which is available for determining measurements of a similar kind, that is to say, for measurements of other cover glasses with the same objective, ocular, diaphragm and tube length. The focussing differences are always to be multiplied by this factor in order to obtain the true thickness of the layer.

As an example—Objective DD Zeiss, diaphragm 8 mm in diameter; tube length 155 mm.; and four cover glasses, the thickness of which, already ascertained, are 0.146, 0.168, 0.187, 0.22. The focussing differences marked by the head of the fine adjustment screw were 35, 40, 45, 52 divisions. Then the reduction factors in $1/1000\mu$ are $\frac{146}{35} = 4.17$; $\frac{168}{40} = 4.20$; $\frac{187}{45} = 4.16$; $\frac{220}{52} = 4.23$; or on the average 4.19, say 4.2. If the thickness of these cover glasses had not been known, but the focussing difference had been obtained and multiplied by 4.2, the results would have been 0.147, 0.168, 0.189, 0.218, instead of 0.146, 0.168, 0 187, 0.22. Differences of + 0.001, 0.0, + 0.002, — 0.002; a result more than sufficiently accurate for the purpose.

It is also exceedingly important to know the thickness of the cover when using non-adjustable objectives. These lenses are corrected by their makers for a certain thickness, and as the adjustment cannot be changed, and since the microscopist, until recently, has not known for what cover thickness the objectives were intended, he was at the mercy of circumstances, and forced to accept and be content with whatever image he could get. Now we are able to use covers of at least approximate correctness with our non-adjustable objectives, thanks to Prof. S. H. Gage, of Cornell University, who has investigated this matter. Prof Gage submitted certain questions in relation to the subject to the various opticians of the world, and from his published results I take the following, so that the reader, if he possesses non-adjustable objectives by any of these makers, may use covers of the proper thickness to obtain the best results, provided his microscope body tube is of the standard length:

$\frac{25}{100}$ mm.	J. Grunow, New York. H. R. Spenser and Smith, Buffalo, N. Y. Wm. Wales, New York. Powell & Lealand, London.
$\frac{16-30}{100}$ mm.	Ross & Co., London.

$\frac{16}{100}$ mm.	Bausch & Lomb, Rochester, N. Y.
$\frac{15-20}{100}$ mm.	Carl Zeiss, Jena.
$\frac{16}{100}$ mm.	Zeiss for his Apochromatic oil immersions.
$\frac{15}{100}$ mm.	The Gundlach Optical Co., Rochester, N. Y. R. & J. Beck, London.
$\frac{12-17}{100}$ mm.	J. Zentmayer, Philadelphia.
$\frac{10-12\frac{1}{2}}{100}$ mm.	Nachet et Fils, Paris.
$\frac{10}{100}$ mm.	Swift & Son, London.

The glass, which is said to be crown glass, from which the covers are made, is brittle, and until the microscopist becomes somewhat of an expert he will break them with amazing facility. The skill needed in handling the fragile things is easily acquired, but reasoning from the number of devices recommended for the purpose, their inventors have despaired of acquiring that skill themselves, and have judged others by their own standard. Many and peculiar cover glass forceps are obtainable, all more or less useful, perhaps, but I have never tried them, having always relied on my fingers alone. The simplest device, and one readily made by any novice, is the following, recommended by Mr J. C. Douglas, in the *Journal of the Royal Microscopical Society* for 1881, where he says that he long wanted "a simple appliance for picking covers out of the liquid in which they may be soaking, selecting them from their box, placing them flat upon the object to be examined or mounted, and picking them off the slide when necessary after examining the object covered. Forceps and needles have grave inconveniences. Chase's mounting forceps simply drop on the cover, and are inferior, both in simplicity and utility, to the following plan: Cut a piece of suitable size from a flat rubber ring; fix this, by a large headed pin, cut short, on to the end of a cedar stick, driving the head of the pin so as to form a depression in the rubber; wet the rubber, and on pressing it against a cover glass it will adhere to it, and the glass may be manipulated as desired. To disconnect the rubber from the glass, it is merely necessary to incline the stick so as to detach the rubber at one edge, when the adhesion ceases at once. The apparatus is more durable if a little cementing material be used on the stick, as the pin sometimes draws through the rubber."

Personally I prefer to get along without any other help than a fine needle in a match handle, using the needle to lift the cover so as to take it in the fingers, and also as a means to lower

it slowly over the object after having placed one edge against the slide, supporting the opposite margin by the needle. In this way the cover may be very gradually depressed or as slowly raised.

GLASS SLIPS.

Slips should be of the best and whitest glass, without bubbles, striæ, scratches or flaws of any kind. They should also be so smooth and so perfectly flat that when they are pressed together they will adhere to each other. The best size is that commonly used in this country and in England, three inches long by one inch wide. Many cheap slides of French or German origin measure only two and three-eighths by five-eighths. These are entirely too small, and should never be used. In Germany, again, slips are sometimes made measuring one and seven-eighths by one and one-eighth; occasionally three and one-half by one and one-half inches. There is little advantage in using these uncommon dimensions. They cannot be conveniently stored away in any ordinary cabinet, and they are not so easily handled as are those of the standard size.

The edges should be smoothly ground. Many of the best have the edges also polished, and this is a pleasant thing to look at, but not a necessity. Roughly cut margins are to be avoided if the microscopist cares anything for a whole skin on his finger ends, and an unmarred stage to his microscope.

Slips immediately from the dealers are usually as greatly in need of cleaning as are thin covers. Many microscopists immerse them for several days in a solution of bichromate of potassium, two ounces; sulphuric acid, three fluid ounces, and water, twenty-five ounces. I have never found any of these cleansing fluids necessary. A good rubbing with a soft cloth, a thorough rinsing in warm water, and the application of a little human saliva, are usually all that is needed. The fastidious microscopist is not supposed to know the worth of his saliva for any but digestive purposes, yet he will find it of peculiar value in cleaning microscopical slips and thin glass. It will sometimes accomplish what acid will fail to do.

The thickness of the slips should be considered when purchasing them. I should advise the beginner to avoid the thick as unnecessarily weighty and cumbersome, and to select the medium or the thin. If no sub-stage condenser is to be used, then the medium will answer every purpose, and even when

that accessory is to be employed, those of medium thickness will probably be all that are needed. The only objection is that they may interfere with the proper focussing of the condenser, as the thin slips will not. Some persons cut their own from the best glass obtainable, but when the color, imperfections and rough edges are considered, whatever is gained in cost is not offset by any other advantage. It is more economical in the end to buy the best slips offered by the dealers.

SOME time ago Mr. George C. Taylor, of New Orleans, sent me for examination a microscope lamp, of his own invention so far as its essential and peculiar parts are concerned. I had become so interested in Mr. Taylor's epistolary description of the appliance, and of what he had been able to do with it in the study of Diatoms, that I welcomed it with enthusiasm and with great expectations, which have not been disappointed, as great expectations so often are disappointed. The lamp has so fully substantiated Mr. Taylor's reports of its valuable qualities that I have succumbed to the temptation to describe it somewhat extensively for the reader's benefit. Mr. Taylor is generous enough to have placed at the disposal of all microscopists the principle and its application, as well as to any dealer in microscopical supplies that may be disposed to bring it into the market.

The lamp is, with one exception, made on the principle of the old Hitchcock lamp, in which the flame was rendered more than ordinarily intense by a forced draught, produced by a rapidly-rotating fan driven by clock-work. In Mr. Taylor's application of this, for which he claims no credit, the machinery is contained in an urn-shaped vessel, from which the air is conveyed by an appropriate means to a lamp at the opposite end, where it partly counterbalances the weight of the motor. Through the air passage is an aperture for the upright brass rod that is screwed into a heavy tripod base, and carries a bull's-eye con-

densing lens. The strong air blast is carried by very simple means around the oil reservoir to the base of the flame, which burns with an intensity that to the naked eye is almost painful, and with a pure and steady white light without a chimney, as did its prototype, the Hitchcock contrivance.

But the feature that at once commends Mr. Taylor's lamp to the microscopist is the manner of regulating the draught and the consequent intensity of the flame. This is accomplished by a rotating diaphragm on the upper surface of the vessel that encloses the machinery. By rotating this diaphragm, and of course thereby opening or closing the aperture that admits the air to the fan, the flame can be made a smoky and disgusting thing, or a small, steady blaze, whose fierceness is painful even to the trained eye of the microscopist accustomed to all kinds of diatomaniac, not to say diabolical, illumination. With this white, fierce flame, regulated so that its tip is just above the cap of the burner, the effect on the lenses used and on the Diatoms examined is remarkable. With the highest power of objectives and eye-pieces there is a superabundance of light, of a quality that seems to clutch the Diatom with a peculiar force, that appears to compel it to give up its striæ and beads, with a sharpness and a brilliancy that at the first view astonishes as a revelation. Objectives that have done well before do better now; those that previously did not entirely well now act in a pleasing way.

With it a balsam-mounted *Surirella* can be resolved into beads by a dry 1/5 with an angle of 135°. A balsam-mounted *Amphipleura*, to the proper objective, reveals its longitudinal striæ. Nothing more need be said in this connection. The diatomist now knows it all.

Mr. Taylor's lamp is superior to the Hitchcock invention, meritorious as that was in several particulars. It is more satisfactory, because it can be more easily manipulated by a change of position. The Hitchcock lamp was immovably fixed at a certain height; Mr. Taylor's diaphragm lamp can be raised or lowered to suit the necessities of the case. It can also be arranged to carry a bull's-eye condensing lens, although, for the study of Diatom markings, that seems scarcely needed; there is plenty of light, more indeed than the microscopist well knows what to do with; and as for its brilliancy and intensity, they are indescribable. But the crowning feature is the diaphragm,

that puts the flame under the complete and undisputed control of the microscopist.

The lamp is praiseworthy; it can scarcely be excelled for Diatom work, and I take pleasure in having Mr. Taylor's permission to refer to it in this public way, and in commending it to the student of the Diatoms who needs a pure, white and exceedingly intense illumination. This lamp will give him such a flame, and it will show him a crisp, sharp and exquisite resolution of the most difficult tests that it will do his soul good to think about.

I know nothing of its cost, but it is certain that a single one would be much more expensive than if a quantity could be manufactured at one time. As Mr. Taylor has said, to soothe my moanings and expressions of longing, if the microscopist possess the machinery of an old and discarded Hitchcock lamp, which never came into general use and never could, he can readily make the other parts of the contrivance, since only an air passage is then needed to lead the draught around the oil reservoir to the flame within the cap. The lamp has been described, I believe, before the American Society of Microscopists, but its merits for the special work it is intended to do gives it claims on the attention of every progressive investigator and upon some enterprising dealer in microscopical supplies that can see his way clear toward placing it in the market.

IN THE November number of THE MICROSCOPE will appear the first installment of a series of papers on Elementary Microscopical Mounting. The chapters are written by Dr. A. M. Webster, who describes the various processes in a way that is exceedingly explicit, giving reasons for every step and for every opinion, doing so in a very pleasant manner. The chapters will be especially gratifying to the "beginning microscopist," of whom so much is heard. Indeed, no one can ask for help that shall be more comprehensive and more explanatory than that contained in these interesting papers by Dr. Webster. He and "An Amateur" discuss the thin cover and the slip; there will therefore appear a slight repetition of facts, but it has been thought best that this should be so, rather than to submit one or the other writer to the blue pencil, and thus make one series somewhat incomplete.

ACKNOWLEDGMENT.—To Dr. H. M. Westover, St. Joseph, Mo., for several slides of Western fresh-water Diatoms, oak-leaf fungus and blood of frog. The last mentioned is mounted in a unique and pleasing way, two small covers being used side by side, the stained corpuscles under one, and below the other the unstained blood for comparison.

NEWS · FROM · THE · WORKERS ·

A NEW SYSTEM OF ERECTING AND LONG FOCUS OBJECTIVES.—M. L. Malassez,* after referring to the advantage of erect images and long focal lengths, when delicate dissections have to be made, exact measurements determined, etc., writes:—

For these purposes we have already at our disposal the simple lens or the doublet, the Brücke lens, and the ordinary compound microscope furnished with erecting apparatus. These instruments are excellent in certain cases, but are certainly unsatisfactory in many others. Thus, the simple lens and the doublet do not give sufficiently strong magnifications with foci sufficiently long, and, in making use of them, it is necessary to bend over the object to be examined in a very uncomfortable way. The Brücke lens possesses the advantage of having a very long focus, but the magnification which it affords is not very considerable. The microscope itself gives all the magnification desired, but as soon as this becomes at all considerable the focus is very short, and there is no room for manipulation.

I have devised a new system of objectives which gives the best results. Adapted to the ordinary microscope the objective gives at once, without erecting apparatus, an erect image of the object obtained. Its focus is very long, as long as could be wished. One of them has a focus of seven centimetres, while it gives a true magnification of thirty diameters with a No. 2 eye piece of Vèrick, and a tube length of sixteen centimetres. I have made some which had foci much longer, reckoned by metres instead of centimetres. With these it was possible to

*J. R. M. S., Ch. Arch. de Med. Exper.

see with the microscope objects placed at the other end of the work-room, or even objects more distant still, such as houses and monuments, at a distance from the window. However, as we lose in magnification and light what we gain in length of focus, it is of advantage to limit this as much as possible.

These new objectives possess the further advantage of considerable penetrating power, *i. e.*, it is possible to vary the focus without losing the object. The one mentioned above has, for instance, a penetration of two to three millimetres. It is possible to get more, but it is necessary to limit it, for it would be at the expense of the defining power, *i. e.*, at the expense of the clearness of the images.

The field of view is sufficiently large; that of the objective already taken as an example is from eight to ten millimetres in diameter. With it microscopic images are obtained perfectly plane. The field is of course enlarged, as the magnification is reduced. The device by which I have obtained the two principal properties characteristic of this new system of objectives, viz., the erection of the images and the indefinite length of the foci, is as follows:—

The different lenses composing the objectives really form two distinct optical systems, each acting as a single convergent lens. One, called, for convenience of description, the first lens, occupies the lower part of the objective next the object to be examined, while the other, called the second lens, occupies the upper part in connection with the microscope tube.

Matters are so disposed that the first lens gives behind it and in front of the second an inverted image of the object, and the second then gives behind it an inverted image of the first. It follows from this that this second image, inverted in relation to the first, is really erect in respect to the object. As this is the image examined by the eye-piece which does not invert, it accordingly remains erect with respect to the object. In other words, the aim of the first lens is to give an inverted image of the object; while the second acts as an ordinary objective, and with the eye-piece constitutes a compound microscope, so that we examine with this microscope not the object itself, but an inverted image of it, produced by a lens placed in front of the objective, between it and the object. The microscope, as it inverts anew this inverted image, gives a final image which is erect with respect to the object examined.

The possibility of obtaining with these new objectives very long foci, and of any length desired, is very easily explained. With convergent lenses the farther the object seen the nearer to the principal focus is the image on the other side of the lens, so that if it is wished to receive it on a screen, or to examine it with an optical apparatus, it is necessary to approach the nearer to the principal focus. Reciprocally, when very near the lens, it is only possible to see the images of very distant objects; and, on the other hand, when receding from it, only those of objects very near. Similarly, with this new system of objectives, if the second lens is brought near the first, only very distant objects can be seen, and accordingly the focal length of the whole system will be augmented, while by separating the lenses the focal length will be diminished, and only nearer objects can be seen. I have made one of these objectives in which the two lenses can be approached or separated at will, so as to vary at pleasure the length of the foci, and to see with the microscope objects more or less distant. In practice, however, I think that it is better to use objectives with fixed focus.

The idea of erecting microscopic images by means of the objective is not new. The first of these new objectives was constructed by me eleven years ago, and was shown then to many persons, amongst whom was M. Vèrick, who undertook to make similar ones. He did not do so, but his successor has been engaged under my direction in this new work. Any maker will be able easily to do the same after some trials.

ANOTHER STAGE LEDGE.—To a plain stage clips are perhaps a necessary evil. They may "scalp off the cover," rub off labels, hold the slide down too tight, or so loosely that it gets away from them, according to the thickness of slide used. When using the microscope horizontally one can very well do without the clips, but in the convenient inclined position something is absolutely necessary to hold the slide in place.

A writer in THE MICROSCOPE suggests a ledge made of a strip of lead. I think I have something far better. Take a two-foot pocket rule, cut out a piece in length the exact width of your square stage. To each end rivet a strip of sheet brass or tinned copper; bend these strips downward, then inward under the stage plate. These strips will serve as springs to hold the ledge to the stage. Remove, or turn back the clips, slip the ledge onto the stage from the front, place the slide in front of the ledge, and proceed to work. You will not use it very long till you will wonder why the maker of the microscope did not provide such a ledge. With thumbs and forefingers grasping ledge and slide, you have complete control over two movements at right angles, as you have with a mechanical stage, and you can go over the whole mount in successive fields of view and know that no part is missed, just the same as with a mechanical stage. Besides, the markings on the rule serve admirably for finding an object. In the foot rule we find a ledge almost ready made for use. It is easily fitted to stage; looks well and works well.—*Dr. H. M. Farr.*

USEFUL CEMENT.—I have for sometime been experimenting with cements, with more or less dissatisfaction. I seal all glycerine mounts with Apathy's cement, which I find to be very satisfactory. Formerly I backed it up with a coating of shellac followed by asphalt. I was not quite satisfied with that, and at the suggestion of Mr. E. H. Griffith, tried Berry Bros.' hard oil finish. I use it thinned to the proper consistency with benzol. I keep two stocks, one transparent, the other black, prepared by grinding lamp-black into the transparent varnish. These I find sufficient for all my work, and much superior to the shellac and asphalt combination.—*Wm. N. Beggs, M. D.*

A WASH BOTTLE.—In the side of a bottle drill a one-eighth inch hole half an inch below the cork; bore the cork so as to receive the end of a funnel, to which is attached a rubber tube long enough to reach to the bottom of the bottle inside. Fill the bottle half full of water, add the sections or other objects to be washed, fit in the cork carrying the funnel into which is fitted a disk of filtering paper. Place the funnel beneath a water tap and allow a gentle stream to trickle into it. The water will pass

to the bottom of the bottle and out through the hole in the side, a constant change being thus brought about. I generally allow the apparatus to do its work at night.—*John W. Morris.*

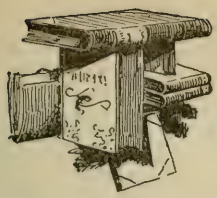
CHEAP WOODEN FORCEPS.—A convenient forceps for microscopical use may readily be made from the ordinary wooden toothpicks, purchasable for a few cents per thousand. For this purpose select three smooth picks. Cut off about one inch from the end of one and throw the remainder of the pick away. Dip the ends of the others in liquid glue of any sort, to the depth of an inch, place the short piece upon the glued portion of one pick, making the thin ends coincide, and then place the glued end of the other pick upon the short piece, and around the whole wrap a thread or bit of thin brass wire (such as is used in needle-work, carrying the wrapping up to the inner end of the dividing piece. These forceps are useful in many ways, but especially so in lifting cover-glasses from acid-bleaching solutions, etc. A pair can be made in less than a minute.—*National Druggist.*

STARCH IN CHLOROPHYLL*.—It is very easy to prove the existence of starch in chlorophyll. Let the green color be destroyed by immersion in alcohol, or by any other bleaching process; then soak the specimen for a few moments in potassium hydrate to destroy the protoplasm. Testing with iodine, the chlorophyll grains immediately assume the characteristic blue tint of starch, especially in the guardian cells of the stomata or breathing pores. Such a neat experiment, having so much bearing on the question of assimilation, should be performed by every botanist interested in vegetable physiology.

A METHOD OF KILLING AMŒBÆ.†—In order to cause these organisms to become comparatively quiet, Brass recommends feeding them with pulverized organic matter; they are then very slowly killed on the slide by the use of the following solution, while under observation beneath the cover glass: Chromic acid, 1 part; platinum chloride, 1 part; acetic acid, 1 part; water, 400 to 1,000 parts.

* J. M. C., in Bot. Gaz.

† Rep. Fish Com., '82.



NEW PUBLICATIONS

PULMONARY CONSUMPTION A NERVOUS DISEASE.—Dr T. J. Mays, Physician's Leisure Library. Sq. 16mo., pp. 185. Detroit: Geo. S. Davis. Price 25 cents. The author emphatically rejects the *bacillus tuberculosis* as the cause of phthisis, and is equally certain that the disease is not contagious, claiming that it is not due to any single cause, but that occupation, want of exercise, insufficient food, inheritance, excesses of all kinds, sex, order of birth, dampness and change of climate are powerful factors in its production, and that a disturbance of the nervous system plays either a causative or a concomitant rôle in its history. In favor of this belief he brings to bear a host of observations, which he discusses in an eminently readable way. The work is fresh, original, courageous and laughable. The way in which the author tramples over his opponents and marches straight forward regardless of others' opinions is interesting, not to say amazing. He is blinded by his theory, and tramples onward without a guiding cane or even the traditional dog. The book is worth reading, but the author will gain few followers and make few converts.

THE PSYCHOLOGY OF ATTENTION. Th. Ribot. Authorized translation. Chicago: The Open Court Pub. Co.; 12 mo., pp. 121; cloth, price 75 cents.—The purpose of this work is, in the words of the author, to establish and to justify the propositions that there are two clearly distinct forms of attention, one spontaneous, the other voluntary or artificial. The first, although the fundamental form, has been disregarded by most psychologists, while the second alone has been studied, although it is only an imitation, a result of education, of training and of habit, being but an improved instrument and a product of civilization. Attention has been compared to reflex action; it might more properly be compared to a series of reflex actions. A physical excitation produces a movement. In like manner, a stimulation coming from the object produces an ever-repeated adaptation.

Spontaneous attention, when it is deep and tenacious, possesses all the characters of a passion that is never stilled and which is ever striving to attain its object. The dipsomaniac never sees a glass of liquor without drinking it, and were some maleficent sprite to fill it as often as it was emptied, he would never cease to drink. The physical manifestations of attention the author considers to be of great importance, and he examines them at great length, referring to subjective sensation, the change in the breathing and bodily movements, all of which express attention. He also studies the matter from a physiological point of view, inquiring as to what goes on in the brain when considered both as an intellectual and as a motor organ. In the first period of life the child is capable of spontaneous attention alone, fixing the gaze on brilliant objects only, or on the mother's face. Toward the end of the third month it gradually rests its eyes on objects less and less interesting. Later, this fixing of the gaze becomes intense attention and is translated outwardly by the pronounced contraction of sundry muscles. The birth of voluntary attention, which means the possibility of holding the mind to non-attractive objects, can be brought about only by force, under the influence of education. The author considers the subject in all its bearings, treating of the origin of spontaneous attention; the production of artificial attention and the three principal periods of its formation by the action of simple feelings, complex feelings and habits, with the action of attention on the muscles, the morbid states of attention and its physical condition.

The book is valuable and interesting, but the reader that takes it up anticipating an easy time and a pleasant voyage over smooth intellectual seas, will be disappointed. It will demand considerable mental effort, but the result will amply repay any outlay in that direction. It is a welcome addition to the lighter and less abstruse of psychological works.

THE PEDICULI AND MALLOPHAGA AFFECTING MAN AND THE LOWER ANIMALS. Prof Herbert Osborn. 8vo., pp. 56. Washington, D. C.: U. S. Department of Agriculture, Division of Entomology, Bulletin No. 7.—A valuable work on the lice infesting man and the lower animals, describing and figuring most of the known forms. The information here presented can be had elsewhere only by searching through an extensive literature,

as few microscopists can do. The book will therefore be useful, and should stimulate the study of these insects. It is freely distributed to all that ask.

STUDIES ON THE ETIOLOGY OF DIPHTHERIA. Second Series. T. M. Prudden, M. D. Reprint.

ERYTHRONIUM MESSACHOREUM, N. SP. Prof E. B. Knerr. Reprint.

A CONSIDERATION OF SOME PARTS OF A MICROSCOPIC STAND, of interest to pharmacists. Dr. H. M. Whelpley. Reprint.

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PRACTICAL INTESTINAL SURGERY. F. W. Robinson, M. D. Physician's Leisure Library. Detroit; Geo. S. Davis. Price 25 cents.

ACADEMY OF SCIENCE AND ART OF PITTSBURG. Special circular.

PROC. OREGON STATE PHARMACEUTICAL ASSOCIATION. Portland.

EDITOR THE MICROSCOPE :—

Having had the good fortune, a short time ago, to be allowed the examination of a new $\frac{1}{4}$ and $\frac{3}{4}$ inch positive ocular of such a superior character as to excel in quality anything that I have ever seen, I believe your readers will be interested to hear about them.

These oculars are constructed on the Huyghenian principle from a new formula.

The $\frac{1}{4}$ and $\frac{3}{4}$ inch were carefully compared with the eye-pieces of various makers of international reputation and found superior to all.

For clearness of definition, marginal and central, for flatness of field and freedom from color, both marginal and central, these two eye-pieces are superior to anything I have ever looked through.

The marginal definition and correction, which is poor in the ordinary run of oculars, is nearly perfect in these two eye-pieces.

I have in my collection a $\frac{1}{2}$ inch objective (never mind who the maker is) in which the central definition and correction are good, but the marginal poor. On using this objective with these oculars I found a decided improvement in clearness of definition and flatness of field, especially noticeable at the margins.

The $\frac{1}{4}$ inch gives greater magnification than my Spencer $\frac{1}{4}$ solid, and is superior in definition and flatness of field.

The heartiest thanks and good wishes of microscopists are due Mr. Herbert R. Spencer, of this city, for the production of an ocular superior to any in the market to-day.

JOHN A. MILLER, PH. D.

NIAGARA UNIVERSITY, BUFFALO, N. Y.

EDITOR THE MICROSCOPE :—

I think it is in the last number of THE MICROSCOPE that gelatine is recommended for the first ringing of balsam mounts. I have tried the method thoroughly, but have not found it really satisfactory. About a year and a half ago I began using a thin solution of collodion, following it with shellac, then finishing with asphalt, and have found this entirely reliable and very convenient. The trouble with the gelatine has been a tendency to crack, and that even with admixture of glycerine. The collodion, on the contrary, is very tenacious, is hardened at once by evaporation of its ether, and is, in turn, insoluble in the shellac. I presume the shellac is not really necessary, as mounts finished without it have stood perfectly well, but I use it as an additional precaution.

I find that a mount with very fluid balsam may be closed at once, and safely, without the wearisome delay entailed by baking.

Yours truly,

ALBION, MICH. C. E. BARR.

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ORIGINAL COMMUNICATIONS

MICROSCOPE OBJECTIVES.

(READ BEFORE THE AM. SOC. OF MICROSCOPISTS.)

PROF. T. J. BURRILL, PH. D.

I HAD the honor of presenting to this society, at its last meeting, a paper embodying my experience and opinions concerning the microscope. I now wish to offer the results of personal experience in the use of various objectives for microscopical work, especially along the lines followed as a teacher and investigator of biological science. The task thus set before me is more difficult than that of last year. Little niceties of difference count much more in an objective than in the construction of a stage, or rack and pinion adjustment; and though one may be sure that his preference is not founded upon fancy, yet he may find it hard to state in words upon just what special characteristics he bases his choice. In the paper of last year the names of makers were carefully excluded; this time it is impossible to get along without reference by name to the manufacturers of the instruments cited. I heartily wish it could be avoided and accomplish the purpose intended, for it is a source of embarrass-

ment to myself, and is also liable to be seriously misinterpreted. All that can be said in justification of what follows is that I am under obligations to no one, either directly or by implication, except as necessitated by truth and fair dealing, and that all matters of personal interest are thoroughly placed aside, if I am capable of so doing. The articles used are all owned by myself or by the institution in whose service I am, with one somewhat conspicuous exception, and that was loaned to me, upon request, for the purposes of this paper. No comparison is made with such as I have not had abundant opportunity to test, and, with the exception just mentioned, with none that have not been in use during some years of time.

In the paper upon stands, a note was made upon the fact that we are prone to like best that with which we become acquainted. In the case of objectives, however, there is less room for such preference, because the mere handling of one is practically that of others, including the position and movements of one's body when at work. To be sure, in order to get the very best results with a high quality objective, one must patiently learn to use that particular instrument; but this is another thing. The force of habit has little to do in this last case, while it is exceedingly strong in the method of moving the object under the lens, and in the manipulations generally of the stand.

It should also be stated that my work has chiefly been upon uncolored objects mounted in water, with or without the addition of carbolic acid or glycerine, and upon colored objects in balsam; the main exception is that of Diatoms in balsam, and in this case as a test for the objective rather than work upon the objects for their own sake.

MAGNIFICATION.

Whatever may be the facts in regard to the use of high power eye-pieces to secure the requisite magnification in mere tests, for long continued work over the tube anything in the upper end of less than about one inch focal length is unsatisfactory to me. The strain upon the eye is certainly less with the medium and low power oculars, and the image is better to my eye, even with the finest objectives made. I choose, therefore, such focal length in the objective as will give sufficient magnification with a Huyghenian eye-piece, amplifying about ten times as the upper

limit. Higher magnification by the eye-piece may be useful in testing an objective, and may, it is true, to some persons, be available for long continued work; but I am making a report of personal experience. The only other thing necessary to say here is that usually the less amplification, the better, after a suitable amount is obtained. Hence neither objective nor eye-piece should be of less focal length than will conveniently serve the purpose required. For a botanical laboratory a $\frac{1}{2}$ inch and a $\frac{1}{5}$th inch dry objectives are the best selection for the common work of students. Occasionally higher powers are needed, sometimes running up to the highest and best procurable. For these exceptional cases provision should be made by having a few such objectives at hand, but students need not be furnished with them as with those first named. Really serviceable magnification seems to reach its limit in about a $\frac{1}{15}$th inch or at most an $\frac{1}{18}$th inch objective. Only in rare cases is anything of higher power than a $\frac{1}{10}$th inch, of best quality, effectively superseded—with me in nothing but certain studies upon bacteria.

ANGLE OF APERTURE.

It appears to me that something similar can be said of the angle of aperture. In the matter of difficult resolution with oblique light, high class and even medium grade objectives have been, in my hands, proportionally successful in just about the order of their aperture, though exceptions have been noted. But for most other uses, it does not appear that the angle of aperture should be relatively rated so high, in the qualities of objectives. It must not be inferred from this that wide angles are, in and of themselves, injurious for biological work. Other things being equal, I should always prefer them, cheerfully putting up with any lack of penetration, and, to a certain extent, with inconvenient working distance for the other advantages offered; but crispness of outline, of even the smallest bacteria, depends upon something else quite as much as upon the aperture and cost price of an objective. These smallest bacteria measure about $\frac{1}{5000}$ inch, or about the distance apart of the dots from centre to centre of *Pleurosigma angulatum*. We all know that great angle is not necessary upon objects of this size. The question is whether excess of angle above a certain essential degree, is of any importance whatever, or indeed, whether an

objective of wide aperture, is, on this account, especially superior, when the illumination is a narrow beam of axial light? When the object is too small or too slender to be seen by a narrower angle, no doubt can exist even in this case of the essential advantage of the greater aperture, but unless one wishes to see the flagellum of a Bacillus, or the minute structure of a Diatom valve, his laboratory work may, perhaps, be just as successful with first-class objectives, of less than the widest angle procurable. Should these of moderate angle possess better definition (not resolution), then for their proper work they are better lenses. My later purchases for students' ordinary use, have been of 110° air angle for a $\frac{1}{6}$th inch, with the expectation that anything up to the widest numerical aperture may sometimes be accessible. For the closest possible studies upon the exact size (measurement) and shape of small stained bacteria, a Tolles' $\frac{1}{75}$th inch homogeneous immersion of 123° balsam angle is the best I have used, though others at hand have considerably wider aperture.

GET THE BEST.

Having decided what is most suitable for the work proposed, the very best should be selected for students' use, as well as for special investigators. It may be said that the expense would often be too great, and that cheap instruments or none constitute the alternative. Often, however, this is the mere outgrowth of too cheap ideas, either on the part of the instructors or boards of trustees. If the real needs are fairly appreciated, in this as in any other case, they can usually be met in some way. Otherwise how are microscopes obtained at all? At any rate, instructors should inform themselves with the utmost care, and then equip their pupils in the best possible manner, with this, the most delicate of all tools. No questions of home or foreign manufacture, of accidents of popular approval or of hereditary service, should be allowed weight in the selection of a microscope objective. Neither should the cost price be taken as an index of quality. No one can be blamed for buying what he finds to be the best goods, for the least money.

Governed by these principles, I have ceased ordering from abroad for students' use. Without naming other makers, I choose the objectives of the Bausch & Lomb Optical Co., in preference to those of Leitz. I have in daily use some first class wide

angle dry objectives of the Gundlach Optical Co., that have given most excellent satisfaction. Anxious to have the best, as improvements were announced, I have ordered, from time to time, five first class objectives, each one supposed at the time to be the very best in the market. This paper may seem less presumptuous with this statement inserted.

SPECIFIC TESTS.

I am now to report the results of some comparative tests, made with certain named objectives, under described methods of procedure. When the title of this paper was announced, I hoped to have photographs taken in different ways for each objective tried, but have found too much time consumed in other directions to permit it. Please allow me to express the conviction, that these proposed photographs would have certainly corroborated the statements herein made.

In order to decide, with certain correctness, of the relative quality of the objectives compared, the tests were purposely made as difficult as circumstances permitted, but under these difficulties each was given the best handling possible for the manipulator. The objectives, all homogeneous immersions, were as follows:

Tolles' $\frac{1}{15}$th, [1880] 123°; Zeiss' apochromatic $\frac{1}{12}$th, [1887] N. A. 1.40; Herbert Spencer's $\frac{1}{10}$th, [1888] balsam angle 130°; Gundlach's $\frac{1}{12}$th, [1890] balsam angle 136°. The last was asked for and loaned to me for trial. An attempt was also made to include a Leitz $\frac{1}{12}$th, [1888] N. A. 1.25, but it was not possible to use it on the same stand, hence not certainly under the same conditions, and not included in this report. I have not been able, under fairly similar conditions, to make it do what is reported for the others.

The first tests were made upon Möller's balsam mounted test plate, with an ordinary small coal oil lamp, with flat wick $\frac{3}{4}$th inch wide, and common round chimney, on which, however, was placed a tin extension 16 inches long, to improve the combustion and steady the flame. Anyone who sits down to a prolonged task of this kind, will appreciate the latter, at least, of the improvements thus obtained. The lamp was placed 30 inches from the mirror to the left, with the centre of the flame used edgewise, and mirror of the same height. The mirror bar was placed at the angle of 50° from axis of the instrument, and the concave side

accurately focussed by means of the paper label on the test slide. No sub-stage helps of any kind were used. After adjustment of objective and light as described, an ordinary bull's eye, same height as flame and mirror, was pushed in and out at will near the lamp, flat surface to the latter. The tube of the instrument could be closed to $6\frac{1}{2}$ inches, measured from its lower end to top of draw tube, and could be elongated to 13 inches. The Tolles' and Spencer's objectives have screw collars; these were adjusted for their best effect with tube length of 10 inches, measured from front of objective. For the others the tube was varied to suit. It should be said that the Zeiss objective was ordered for the long tube.

Amphipleura pellucida, on this particular slide, is of medium grade as to difficulty of resolution, but as difficult as any I have seen in Möller's test slides. No. 19 is probably proportionally easier often showing by light and adjustments which 18 defies. I think this last is unusually difficult, and the same may be said of No. 12, *Gramatophora subtilissima*. The others seem to be fair, average shells. As immersion media, somewhat thickened cedar oil, as furnished by Zeiss, and a fluid sent out by the Gundlach Optical Co., were used successively with all the objectives, with, however, no perceptible difference in result. The work was done in the daytime, with windows behind the operator, uncurtained. There were no windows in front or at the sides.

Under these conditions, all four objectives resolved *Amphipleura* so plainly that any tyro could make out the transverse lines, at least when the bull's eye aided the illumination. Often the lines appeared the moment the focus was secured, and this could be changed back and forth with almost certainty that they would be evident whenever the proper adjustment was made. I need not say, however, that it always required careful work, and that there were failures as well as triumphs. The two non-adjustable objectives did best with the shortest tube and negative ocular. With Zeiss' compensating ocular, the result was rather more satisfactory with the ten inch tube length. There did not appear to be the same difference with the Gundlach in this respect, the Zeiss eye-piece also showing well with short tube. With the apochromatic at its best, the Diatom appeared perfectly flat with mid-rib and margins, showing distinct and clear, when the lines were in focus, a thing none of the others did, though

Spencer's perhaps came nearest to it when adjusted at 8, with ten inch tube The whole field, too, of the first named, including the object, was beautifully white. With the Gundlach, it seems to me that the lines were as distinct and crisp as with the Zeiss, and could be counted with reliability, a few at a time. When these were best shown the raphe and margins glowed with red, shading to dark, and a little movement of the focus downward was necessary to render the margins most distinct. With a longer tube, the lines more evidently stood above the outline. With the Spencer, at its best, I found little changes of illumination, etc., destroyed the resolution to a more marked degree than with the two others just named, and though the lines were beautifully shown, and the outline fair at the same time, it seemed to me that counting would be a much more difficult undertaking. It should be remembered, however, that the magnification was less, and this I could not fairly make up with higher eye-piecing. Under a solid $\frac{1}{4}$ inch ocular, I was unable to make any distinction in the quality of the lines. With all three objectives they were like parallel ropes, with uneven and woolly outlines.

The Tolles' objective gave the lines readily enough, but partaking somewhat of the character just described, with the solid ocular. With the magnification reduced to that of the $\frac{1}{12}$, by the use of longer eye-pieces, the haziness of lines partially disappeared, but in no way seemed so beautifully sharp as in the other cases. In both the Spencer and the Tolles there was a tinge of red in the raphe, in some cases merging into a dark shade, when the lines showed best under the manipulation of the screw collar.

Upon the whole, it seems to me, the apochromatic, in this special test was really in the lead, though the distinction had to be carefully drawn. The results on other Diatoms on the plate were similar, so far as could be determined, the rating of the objectives remaining the same.

I next tried the mirror in exactly central position, with other things remaining the same, save as the height and position of the lamp and bull's eye required changing. This was varied too during the same test, by inserting a narrow angled $\frac{1}{5}$ inch dry objective as a condenser, taking great care that it was in central position. In each case, to be further assured that the illumination was axial, examination was made by removing the ocular

and looking at the bright spot in the back lens of the objective. The difference in the performance of the objectives was certainly less marked than with oblique light. The required tube lengths remained about as before stated, with, however, less noticeable difference in a given amount of change. I obtained a kind of a glimmer of resolution on No. 19, with the apochromatic and Gundlach's lenses, but nothing with any of them on 18 or 20. The others were well resolved by all four objectives, *Gramatophora subtilissima* giving the most trouble. I have never seen a balsam mounted *Amphipleura* resolved by truly central illumination, though others have reported it with several objectives. When using the condenser named, by moving it only a little to one side, lines could be made out, but no comparative tests of this kind were made.

I had previously tried, with the help of an expert assistant, the three objectives in my possession in photographing violet stained bacteria with central light, showing a scarcely appreciable difference, but favoring the Zeiss and Spencer over the Tolles, unless the increased difficulties with the higher power proved too much for the skill of the manipulators.

I have now to add a word in regard to the durability of the apochromatic, the want of which has been frequently questioned. After about two years' use it became evident that this lens was in some way impaired, and by looking through it from the back with a magnifier, a hazy-granular appearance was noticeable, not due to dust on the back lens. Last March the objective was sent to the makers for examination and repair. It reached me again in July, as good as new, with the statement that the front lens had been slightly decentred and that the repair had been easily made, and was without charge. I have no other information upon this point, neither do I know what interpretation to place upon the granular appearance noted. There is certainly nothing of the kind visible now.

DO WASPS PRACTISE ASEPSIS?

EDWARD GRAY, M. D.

IT IS the remarkable habit, as is well known, of certain wasps,* to provide animal food for their young and to provision the

*All wasps (Riley.)

cells once for all. Noticeable among these is the mud-dauber, *Pelopæus*. The food varies according to the taste of the species — spiders, caterpillars, flies, worms, beetles, etc. Some species select caterpillars for the food of their progeny. But how is the little grub of the wasp to feed upon such prey? If the caterpillar were dead, it would decay like other animal matter and be unfit for food; if unharmed, it would assuredly injure the egg or larva; nor would it submit to be eaten. So, *a fortiori*, as regards those species which store their cells with spiders. The living spider is carnivorous and would consume the larval wasp rather than *vice versa*. What does the wasp in this dilemma? It stings its prey, thereby deprives it of motion, and a store of fresh food is thus at the service of the young wasp. Packard says: "The sting of those wasps which store up insects for their young, penetrates the nervous centres and paralyzes the victim without depriving it of life, so that it lives many days. A store of living food is thus laid up for the young wasp. After being stung, the caterpillars will transform into chrysalids, though too weak to change into moths."

Here is truly a remarkable thing that a wasp should be so unerring with its sting as to hit the nervous centres in defiance of the struggles of its prey. The victim is rendered powerless by the sting and a state of 'motionless lethargy' ensues. Is it due to paralysis, or is it something else? It must be admitted to be paralysis when a caterpillar goes on to develop into a chrysalis, but never attains the adult state. How is it, however, with the spiders. They do not lose their plumpness nor their color; but do they go on to moult? This never happens to the best of my knowledge. The duration of this lethargic state is sometimes remarkable. Thus Mr. F. Dienelt records an instance where such spiders had been kept eight months and over, and through a hard winter. This fact challenges attention and leads to unlooked-for influences. Can spiders exist eight months in a paralyzed state? During all this time they have been deprived of food and water, and yet the abdomen is plump and they look as if only fresh-gathered. A paralyzed vertebrate must die as soon as the reserve-supply stored in the system is exhausted. Why does not the invertebrate also? The laws of the nervous system cannot change among the classes of animals. After an undefined time with most of the captures, and probably

always with certain classes of booty, death comes to the relief of the victims. Now the problem is, What preserves the spider stung to death? Do spiders practise antisepsis? Did they fight bacteria before Lister? Here lies the key to the problem. Others have searched it out already. Mr. Guenzius, a missionary in S. Africa, wrote some time since: "I cannot help thinking that the poisonous acid of Hymenoptera has an antiseptic and preserving property; for caterpillars and locusts retain their colors weeks after being stung, and this too in a moist situation, under a burning sun." The quotation is from Packard, who makes no comment upon it. Is there anything analogous to serve as a guide? There is in regard to the hive-bee. J. Yates, in *Science Gossip* for 1890, p. 122, states: "Bees store up honey manufactured from nectar by a kind of digestion in their honey-sac or crop, and the honey is preserved from decomposition or fermentation by the addition of a little formic acid to each cell. The formic acid is obtained from the poison-sac of the sting; hence the sting, or rather one of the constituents of the poison-sac, is not intended chiefly for defensive purposes, but for the higher and more useful purpose of preserving their food."

As, upon analysis, formic acid has been found, the evidence appears sufficient. Wasp-poison may differ somewhat in composition from that of bees; probably it does so, as the food of the two creatures is different and the needs of their respective young are also different.

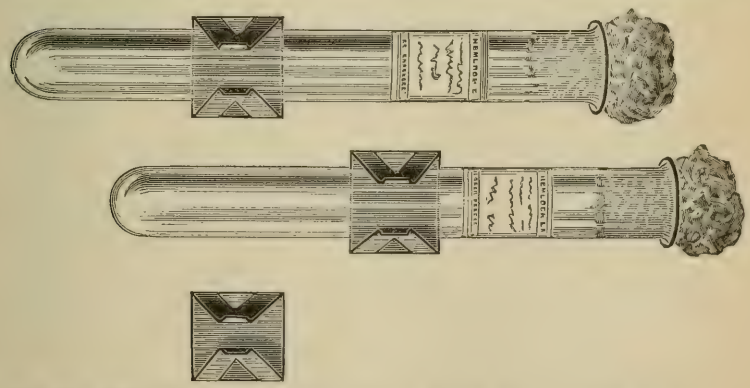
We return now to another question: Why is not preserved food fit for the sustenance of the young wasps? Some will naturally present the objection that the food is poisoned. But it is to be observed here that few blood-poisons are also stomach-poisons; and we know that honey does not poison the bee-grub. Cowan (Honey-Bee, 1890) says, too, that the poison from the sac mixed with the food is given as a remedy in foul-brood. We know, too, that a person may suck a rattlesnake bite and even swallow some of the venom without being poisoned thereby. So long as the prey is prevented from decomposition it may be fit for the young wasps. The state of these spiders can hardly be compared to hybernation. A hybernating animal lives through the winter upon its store of fat, and emerges in spring a gaunt creature. But these spiders which went through even

a hard winter lost no plumpness nor color. To any one who objects that this discussion is confined to spiders as prey, it can only be answered that the reason is that I have observation solely of the species of wasps which prefer caterpillars as food. The contents of eleven cells of *Pelopæus* are now under my observation, but there is no promise of the return to life of any spider, though the nest is but three weeks old. Probably the truth is something like this: that in case of large prey as compared with the size of the wasp, the sting at first only paralyzes the victim. Paralysis may be partial to full, and goes on in many instances, perhaps in the majority, to death. The theory of antisepsis relieves us certainly from the difficulty of believing that the wasp is so unerring a surgeon as to pierce the ganglion in its prey with accuracy, even though struggling. If this article deals with inference rather than absolute proof, it is because the facts are such as to make difficult a conclusive proof of any view. But it is not mere fancy to ask: Did the wasps anticipate the discovery of antisepsis?

CULTURE-TUBE HOLDER.

J. EDWARD LINE, F. R. M. S.

IT IS customary in bacteriological work, whether in the larger laboratories or those characterized by the individual owners as "dens," to stack culture tubes in tumblers, goblets, beakers,



etc., the bottom of the vessel being lined with cotton as a precautionary measure against breakage. In the examination of

these tubes it is necessary to handle them separately, a matter of time and inconvenience. In the device herewith illustrated, a lot of brass knife clamps are fastened, by means of lugs pinched and bent back from the sides, or a tack or screw through the centre, to a piece of card or wood-board, or for transportation, the bottom of a cigar box. When thus arranged they may be hung on the wall, carried about the room, examined, etc., by the dozen, and in this way time saved and inconvenience obviated. The clamps may be had on order of almost any hardware house.

ELEMENTARY MICROSCOPICAL MOUNTING.—I.

DR. A. M. WEBSTER.

PART I.—PREPARING FOR WORK.

A MOUNTED microscopic object is one that is sealed within a cell whose upper and lower surfaces are of glass, the cell margin itself being sometimes square, sometimes circular, and formed of substances that may vary almost as the wish of the microscopist. The essential feature of the mount are the two glass surfaces, the cell wall that surrounds the object, and the medium in which the object is immersed; that is, all of the preparation is important to the success of the mount, and for the pleasure of the microscopist, as well as for his instruction.

There are several reasons for sealing the object within the transparent cell. It can thus be preserved for an indefinite time and always be ready for examination. It is protected from the dust, and from the ravages of insects that, under certain conditions, will destroy our microscopic objects, as well as the carpets and other materials in our houses. Perishable objects can be preserved in a cell unchanged and in minute portions such as the microscope can easily deal with. They can be surrounded with certain preservative media so that their optical qualities shall be so changed that the specimens can be studied with the instrument, whereas, under other conditions, they could be seen only with the naked eye or with the pocket lens, and in large mass. For the microscopical study of an object, therefore, that object must always be passed through certain processes, and be "mounted," as the microscopist calls the final sealing between the two glass surfaces.

It is only within comparatively recent years that microscopical objects have been mounted between glass. In the not remote past they were placed between thin disks of mica, that in turn were fastened within circular apertures in a strip of bone or of ivory. Such mounts are sometimes seen in the possession of those that still have the old-fashioned solar microscope, that was once used in class rooms and by lecturers. Then came an improvement made by the use of glass somewhat as we now use it, but not with the refinement and the delicacy that the modern microscopist can bring to bear upon his preparations, for while the lower glass slip resembled that now used, the upper one was as thick as ordinary window glass; it was, in reality, a part of the same material from which the lower slip had been cut. Such objects were necessarily restricted to examinations with very low powers of the microscope, the high power objectives still demanding the use of a film of mica as the cover to the object. This arrangement survived until there was discovered in an English factory a method of making glass so exceedingly thin that more than two hundred layers of it must be piled upon one another to make them measure an inch in height. A single piece of this thin glass may therefore be only the one two-hundredth of an inch or less in thickness. This is excessively thin and not easily handled, as the reader may imagine. It is very brittle, yet it is needed to cover certain objects that must be examined with the very high powers now demanded by the advanced microscopist. The object is placed on the lower slip, which is usually about the twentieth of an inch in thickness, and the thin glass film is placed above it like a cover, and in the same way as was formerly done with the piece of window glass that was used for the upper layer, or the cover, as it is commonly called. The object, the lower glass slip and the cover glass constitute the slide, or, as the microscopist sometimes calls it, the "mount." Each of these parts claims careful attention.

THE SLIP.

The lower strip of glass—the one upon which the object is usually placed—is the slip; only after the object has been permanently mounted and the preparation is finished, does it become the slide. The slip is usually three inches long by one inch wide, this being the standard size, and in common use in

this country and in England. On the continent of Europe, and by certain microscopists in our own land, there is a smaller size in use. These are about two inches long by half an inch in width. The standard slips are the best and the most satisfactory. They are more easily handled, they are pleasanter to handle, and they look better when the mount is finished. In addition to these reasons, cabinets to hold the mounts are made for standard slides, and, a still more important consideration, by their use uniformity is attained. This the reader will find of especial interest when he comes to exchange some of his preparations for those of other microscopists, as is often done. He would not be pleased to send a finely-mounted slide of the standard size, and to receive in exchange one of the little German mounts, that should rattle about in his cabinet to the detriment of his collection and to the annoyance of himself.

The reader will be wise, then, if he begin his mounting career with the selection of slips of the standard size. These should be of the best and the whitest glass obtainable. They may be cut by the microscopist himself, if he have a diamond and the necessary patience, or he may have it done cheaply; but slips of the proper kind can be had at so reasonable a rate from the regular dealers that it is a waste of time, and usually of material as well, to attempt to cut slips at home. And these home-made productions will have rough and sharp edges, as the microscopist will soon discover, for the sharp edge of the glass is very sharp, and the little cuts they make in one's fingers are likely to make themselves painfully prominent. The slips to be had from the dealers are of the best and the whitest of crown glass, they are perfectly smooth and free from scratches, striæ and other imperfections (or if they are not they should be rejected), and they all have smooth and in some cases polished edges. The beginner should select these rather than attempt to cut them for himself. They should always be perfectly flat, as they usually are, but, to be sure of this, press two of them together by the broad surfaces. They should be so flat and so smooth that the pressure of the air shall hold them together when they are reversed and turned about in various directions. They are also usually free from imperfections; all that are not so should be rejected.

They are obtainable in several thicknesses—the thick, the

medium, the thin and the extra thin. The microscopist may select either that he wishes, although it is well to take the medium or the extra thin. If he thinks that at some time in the future he will want to examine his preparations with high-power objectives and with a modern, wide-angled sub-stage condenser, then he should take the thin or the thinnest medium. If the thick slips are selected, the action of the sub-stage condenser may be interfered with, as it may not be able to come close enough to the object to focus the light upon it. The extra thin slips are, to the writer, not so pleasant to handle as are the medium. The latter are satisfactory and can be used with a wide-angled condenser. The reader will do well to select these, and to confine himself to one thickness, for the sake of uniformity, if for no other reason.

When the slips are received from the dealer they will not be clean enough to be used in the delicate work of microscopical mounting. They must be cleaned; and here is a point that the working microscopist should always remember. It is one of the rules that have no exception. It is that the microscopist, in all his manipulations, should be scrupulously neat. All his slips and thin covers, as well as the objects, should be as clean as clean can be. This is one of the charms as well as one of the necessities of microscopical work. When the object is finally mounted and is placed under the microscope, every little imperfection will become conspicuous, and every little speck of dirt, every thread of lint, every fibre and bit of colored wool, every little shred of wood or of cork cell will become more prominent than the object itself, and may indeed obscure it. To avoid all traces of these extraneous matters is often impossible, but the careful microscopist is ever mindful of them and ever on the alert to find and to dispose of them. Neatness is one of the microscopist's cardinal virtues. His slips should then be scrupulously clean. He can scarcely polish them too often. A good way by which to ascertain if the glass surface is as clean as it should be, is to breathe on it. The vapor from the breath will condense on the surface, and if the glass is clean and smooth the moisture will pass off without leaving momentary and irregular traces; it will melt away in an advancing and regular wave of evaporation; but if the surface is dusty or imperfect, every grain of dust will, for a moment, be surrounded

by a little ring of clear space, distinctly visible; the slip will be irregularly and minutely speckled. Have the surface unspotted and it will be clean as possible.

The dealer's slips are not very dirty, but they must be made less so. The books recommend many preparations, compounded of many and various chemicals, to be used for this purpose. But the slips are seldom dirty enough to need any special treatment. A bath of warm water and soap, with a thorough washing afterward, is about all they will require. If spots should resist this treatment, then the microscopist has always by him an ever-ready fluid that he can use with success. For cleaning glass there is scarcely anything better than this fluid. It will often remove stains and spots that will resist acids. It is his own saliva. Of course it must be as Nature intended it to be, and as the healthy glands secrete it.

In the books will be found many chemical mixtures recommended for this purpose, yet few of them are used, except by their devisers. Dr. F. L. James, a microscopist of experience, recommends the following as a good cleaning fluid for refractory slips. He finds it particularly valuable if they are to be used for making mounts with glycerine, since that is a rather troublesome medium to work with, as the reader will learn hereafter. The following is Dr. James' receipt. He takes a wide-mouthed jar and half fills it with a mixture of gasoline, (or benzine,) turpentine and benzol. The slips are left in this all night. When convenient, take out each slide separately, give it a good hard wipe with a piece of muslin, and polish it with another piece. "Try this plan once," says Dr. James, "and you will never use any other. Slides thoroughly cleaned thus, possess a quality which, in making aqueous or glycerine mounts, is absolutely invaluable. While they are optically and practically clean, such slides retain upon their surface an exceedingly tenuous film of resinous matter that prevents water or glycerine from attaching itself to the surface, and the consequence is that the surplus fluid, after a cell is closed, rolls off the slide without moistening it in the least. Cement, on the contrary, attaches itself with extraordinary firmness and evenness." A strong solution in water, of common washing soda, has also been recommended for this purpose. The slips are placed in it and left there for an indefinite time. Care should be taken that the solu-

tion is always above the slips and that it is not allowed to dry on them, since it can then be removed with great difficulty, usually not at all, as it appears to have a chemical action on the glass.

But as already intimated, the reader will scarcely ever need any chemical preparation for the cleaning of his slips. I have been using them for several years and never have I felt the need of anything except warm water and soap, with the occasional application of a little saliva. I am sure that the reader's experience will be the same.

When the slips have been cleaned, it is necessary to keep them clean, as well as free from scratches. To do these things some microscopists pack them away in drawers, after having arranged little pieces of blotting paper between the ends. Others arrange them in little packages and surround the four sides of each package with tissue paper, pasting it so that no dust can enter, and so that there may be no sliding movement among the slips. Each one is then easily removed by breaking the thin paper, and without disturbing any of the others.

An equally simple and as useful a method, is to store them in rack boxes with tightly fitting covers. These rack boxes are made of the proper size, and have along the sides strips of wood cut in grooves, into which the ends of the slips are placed, and from which they may be easily removed. The reader can doubtless devise some method of his own, that will serve the purpose as well as any of the ways already described by working microscopists. One's own methods are often more satisfactory to one's self, than are the devices offered in the books or by microscopical friends. The only purposes to be remembered and aimed at, are the cleanliness of the slips and their freedom from injury. The methods by which these things are accomplished are of little importance.

Slips and covers are made of crown glass, and for a reason that the beginning microscopist would not be likely to guess. There is usually a good reason for all things and methods microscopical, although the microscopist that uses the one and does the other may not be able to give that reason. Slips and covers are made of crown glass because the front lens of the objective with which they are to be used is made of it. The light, thus passing through the same kind of glass, suffers the same amount of

refraction or bending, and the optician is thereby enabled to give us objectives that will do better work than he could if the slip and the cover were different in composition from that of the front of the objective. Some of the lenses that form the objective are of flint glass, and in the celebrated apochromatics made by Zeiss, of Germany, some of these component lenses are of fluor spar. But usually the objective is composed of crown and of flint lenses, the flint correcting certain undesirable optical qualities introduced by the crown glass lenses.

This principle of similarity in composition of slip and cover and front lens is carried still further in the homogeneous immersion objectives of modern times. Here the front of the objective is wetted with a drop of fluid medium whose optical qualities are, as nearly as possible, the same as those of the slip, the cover and the front lens; and if the object is mounted in a proper medium, the entire combination forms one homogeneous whole, through which the light from the microscope mirror passes without suffering very noticeable optical change until it has entered through the front lens. These are the best objectives made by the modern optician. Water immersions, in which a drop of water is placed between the front lens and the cover glass, are better than dry objectives, that are used without water or any other medium except the air between their front and the cover, because the water drop acts in a manner somewhat similar to the drop of homogeneous immersion medium, although not to the same perfect degree.

MORE ABOUT CEMENTS.—I.

J. D. BECK.

INVALUABLE articles have been written on the nature of cements and varnishes for finishing mounts. I feel my incompetence to enter a field among superior microscopists with my suggestions, except on important points which, in my opinion, have been overlooked, as I do not recollect to have read any comments as to the applying of anything on top of the cover glasses of mounts. For objectives of low power, this answers very well, if it is a good, hard and elastic varnish or cement, fixing the cover-glass securely, but when it is desirable to use high-power objectives of short working distance, these

rings, thus applied, are in the way of the lens, which is more or less liable to injury by contact with the ring of varnish on the cover. I perceive, however, as I look over my collection of slides, that many microscopists never or seldom allow any cement or varnish to rise above the upper surface of cover-glasses. This effectually prevents all trouble with high-power objectives, unless the cover is not parallel with the slide, a very common annoyance, but it does not hold the cover as securely as a thin coat of hard and elastic finishing varnish applied around the edge with a very narrow ring on top, being sure that there is no break between the ring at the edge and that at the top.

Many cements have been prepared and are in the market which are very defective in preparation and formula. In a former article I recommended Winsor and Newton's picture varnish for finishing mounts. It makes a neat finish, but is not a durable coating. All the cements prepared from dammar, mastic, shellac, gum arabic, and all the other gums or resins, to my knowledge, (except copal, amber, and a resin or gum nearly as colorless and hard as glass, which resisted fifteen solvents, and for which I have not yet found a solvent nor a name,) all are too soft and brittle, and therefore unfit for cements or varnish.

White zinc cement, according to my collection of mounts and all that I have purchased, and made myself, is the most defective of all cements. It is not necessary to enter into an argument, or a controversy to prove this question, with any pet theories. As a practical test, "the eating is the proof of the pudding."

When I examine the slides received from Europe and from every State in the Union, I find that the rings of white zinc shellac, dammar, Brunswick black, marine glue, etc., have prismatic colors between them and the slide, an evidence that the cement has cracked loose from the glass. Some of my own preparations have also cracked and curled up in the course of time. My slides are in a cool room, seldom heated to 90° F., in the Summer, and never below 40° F., in the Winter, and not exposed to sudden changes of temperature.

I have resolved to put all cements for my own use to the following practical test: spin a ring on a clean slide and let it harden thoroughly, then push a sharp pointed scratch-awl, or a sharp brad-awl through the ring, cutting a groove just wide enough for the tool to pass. This repeated a dozen times on

one ring should leave sections, not less than $\frac{1}{16}$ inch long intact, between each incision, and so hard that no impression can be made on the ring with the edge of a stout thumb nail. This I consider a reliable test. But if large sections of the ring fly away, leaving no trace of the cement on the glass when tested in this manner, as do all the white zinc cements that I have bought of the opticians, it is, without any exceptions, a nuisance.

It is impossible to prepare a good and reliable cement or varnish out of poor or improper materials; nor is it always possible to prepare a good article out of the best material, if improperly proportioned, or if prepared in a hasty and careless manner.

When the best glue or gelatine is soaked in cold water all night and then boiled in a water bath till thin and thoroughly dissolved by frequent stirring and by adding to it prepared chalk, chloride of sodium, glycerine (C. P.) and acetic acid in the proper proportions, we have a reliable cement for mounts and labels that will never crack nor scale off.

I have found the following original formula good; but it may be improved, I think:

1. Reduce 6 drams of dry gelatine to a thin solution in distilled water—soaked over night cold, and boiled in a water-bath. 2. Reduce 1 dram of prepared chalk to a thin solution in distilled water, and add to it 1 fluid dram of a strong solution of chloride of sodium (half that quantity of strong alum solution, or a little chloride of calcium may be better,) and stir it well; then pour it quickly into the gelatine solution, and stir the whole thoroughly, boiling it until as thick as can be poured into a bottle with a large neck. 3. Mix 1 fluid-dram of alcohol, 95 per cent., into a fluid dram of sulphuric ether; pour into the gelatine and mix well. If too thick, thin it with acetic acid to suit, and add 6 or 7 drops of glycerine, (C. P.;) mix the whole thoroughly with a clean stick.

Do not insert the cork and shake the bottle with the ether and alcohol in it, or it will generate sufficient vapor to burst the glass or blow the cork out with half the cement. When it gets too thick in a warm room through evaporation, thin with alcoholic ether if you want it to dry faster, or with acetic acid to dry slowly.

Try it on glass, and if too brittle and liable to crack, add more glycerine, say two drops at a time, mixing well and repeat

if necessary, until the cement will dry hard in from two to five hours; if, at the end of two weeks, (in a warm room) it will bear the test referred to above, it is sufficiently hard for filling up around balsam mounts, which have become hard and solid; for labels it has no equal.

Pour some of this cement into a 1 drachm phial and color it sufficiently with a strong solution of black "Diamond" dye, and you have a beautiful black cement. With "Diamond" dyes you can give it any color. In this case, the acid must be left out as it will precipitate the dyes and spoil the beauty of the cement. Alcohol, 50 per cent., will have to be used in lieu of the acid, and the mixture placed in warm water, if too cold or thick.

USUALLY the only immersion fluids at the microscopist's command are water, cedar oil, and glycerine made dense by dissolving in it either cadmium sulphate, zinc carbolate or some other salt. With homogeneous immersion objectives, or those using an immersion medium with a refractive index as nearly as possible that of crown glass, so that the cover, the immersion medium and the front lens may form one homogeneous combination, with these objectives, water of course cannot be used, so that the microscopist must have resinated cedar oil or the glycerine solutions just referred to. But to obtain the best results from these first-class homogeneous immersion objectives, it is important that the immersion fluid should have the proper refractive index, that of crown glass being 1.5, of cedar oil 1.515, the glycerine fluids varying in a way that the microscopist has usually no means of finding out. Prof. H. L. Smith has devised a simple and successful little instrument for the measuring of the refractive index of such liquids, but, so far as I know, it is not in the market. The microscopist must therefore rely on the optician that sometimes by accident plays him false, and so deprives him of the best that his objectives can do.

I have recently had an experience with these substances that has taught me, if not wisdom, at least caution in blaming my objectives or even my own lack of manipulative skill.

A certain homogeneous immersion objective, of not large numerical aperture, was said to be able to resolve *Amphipleura pellucida* well and easily. I made the attempt, and failed, after several hours' work with the lens, using all the care and skill that I possessed. The immersion fluid used had been prepared and sold by a prominent optician, and I had no thought but that its refractive index was what it should be. Another evening was given to the examination of the lens over the same Diatom; failure. A third evening was devoted to the same work, and failure was the reward. I then gave it up, and condemned the objective or my own skill, being disposed toward lack of confidence in the latter. Yet others had said that that objective would resolve that Diatom. A fourth evening was given to it with the same result. Then it suddenly seemed stupid not to think to try another immersion fluid. There might be something lacking in this. I had cedar oil from a well-known European optician, and with a drop of it the objective was focussed, with the light as oblique and the mirror exactly as before, when the lines on that shell stood out, if not like the pickets on the fence, at least with a sharpness, clearness and neatness that was as delightful as it was amazing. In the twinkling of an eye the Diatom was resolved to perfection, while with the glycerine fluid, failure and discouragement had been the only results. The objective was vindicated and so was any skill that the observer might, in a moment of self-complacency, imagine to be his. But on the table were two other glycerine fluids, one by a prominent and accomplished optician of this country, the other by a famous American, who is by all odds the equal of any optician in the world. The immersion fluid from the latter refused to have anything to do with those lines; its action being similar to that of the composition first tried. But the objective was not at fault, nor the adjustment.

The other fluid was then tried, and the resolution was in every respect the equal of that made with cedar oil; if anything it was superior. But there was as usual the fly in the ointment. To remove the glycerine from the objective it is necessary to wash it off with water, but in this case, when the water drop was

added, I had a moment of anxiety, for the fluid became white and opaque as milk, and I could see white particles falling on the lens front, like little flakes of snow. Investigation proved that the salt dissolved in the glycerine, a solution which makes so perfect an immersion medium, acts chemically on the nickel plating of the objective, and the glycerine, seizing the water, allowed the new salt to fall in opaque white particles. The chemical action is so great, that after using the medium but three times, there was deposited on the cover of the test-plate an iridescent film, having an irregularly circular outline, showing where the fluid and the metal had been in contact. Nor is this all, for across the surface of the front lens itself, is a streak of the same insoluble iridescent deposit. The optician declines to make known the composition of the fluid, although he might reveal it with confidence, since no microscopist would ever make the medium for his own use after having a little experience with it. Its action on brass is similar to that on nickle, and must forbid its use as an immersion medium, although it is really the equal of the renowned cedar oil. To the latter, useful as it is, valid objections are its tendency to flow too freely, and the trouble needed to clean it from the lens, alcohol being demanded to remove it entirely, whereas with glycerine, a drop of water is enough. Cannot some of our opticians give us a glycerine medium with the refractive index of the resinated cedar oil, but without the obnoxious quality of the fluid that acts on the objective mounting? For these learned men, the problem should be an easy one. The maker of the dangerous glycerine mixture can surely make something as good; I hope he will never make anything quite so bad, although in its optical action it is as nearly perfect as need be wished. Its hunger for metal is the fatal objection to it.

Upon the optical action of the immersion fluid depends the optical action of the homogeneous immersion objective. If the former is not of the proper index, the microscopist may deceive himself by believing that his objectives are giving him the best possible results; or if they seem to be optically defective he should remember that the fault may be in the fluid supplied by the dealer. The optician should place at the disposal of every microscopist some simple device by which the refractive index of the immersion medium may be ascertained. Zeiss sends out for this purpose, a wedge of glass, which, when used as directed, gives the

desired information. Prof. H. L. Smith's device is not obtainable, and that of the German optician can be had, I suppose, only by buying one of his homogeneous immersion objectives. Without some such means, the microscopist can never know whether he is getting the best work from the objective or not, unless he attempt to resolve the proper Diatom every time he begins to use a fresh supply of immersion medium, a method that would be time-consuming, and should be unnecessary. While with the improper fluid he may get moderately good results, with a medium of the correct refractive index, he will get the best that the objective can give, provided of course the lens be properly manipulated.

Mr. Herbert R. Spencer, (Spencer & Smith, Buffalo, N. Y.,) is introducing a new series of homogeneous immersion objectives at a moderate price, and intended, as the makers say, to take the place of the cheap foreign objectives now becoming so popular in this country, and more than filling their place. The objectives, by change of collar adjustment, correct for water, glycerine and for homogeneous immersion fluid. They are said to have a remarkably long working distance, and to resolve the difficult tests in balsam with mirror illumination alone. I have not seen any of these new lenses, but Mr. Spencer's word in reference to their good qualities is sufficient His work is always, and in every way, exactly as is claimed by the accomplished workman.

Spencer's improvement in eye-pieces, as recently mentioned by Prof. J. A. Miller in THE MICROSCOPE, merits attention by microscopists that desire the best optical appliances in their efforts to pry into things, but unfortunately the improvement cannot be applied to an ocular below the one inch in power. The two inch, so much used by all working microscopists, cannot be successfully made by the improved method, by reason of the great size of the component lenses ; no body-tube as now made is large enough to receive the improved two inch eye-piece. Hitherto comparatively nothing has been done toward the improvement of the Huyghenian ocular. There is room here for some progressive optician to do good work that shall help himself and microscopical science at the same time. There have been so-called achromatic eye-pieces made in Europe, but they have never come into general use, and have attracted little attention.

Their defects have usually been greater than their merits. But if Spencer, Bausch & Lomb or Gundlach should take the subject in hand, something satisfactory would probably come of it. Achromatic sub-stage condensers are beginning to be demanded by advanced microscopists, and are beginning to be manufactured in Europe; why should we not be supplied with improved, achromatic oculars? They will be in request before long, and the optician that first gets them into the market will reap the harvest and the honor.

Messrs. J. W. Queen & Co. have just issued a catalogue in English of the microscopes and objectives made by Reichert, of Vienna. With this firm on one side of the continent, and Dr. Edward Gray on the Pacific coast, microscopists that want any of Reichert's lenses should be able to get them without delay. His optical work equals the best. His semi-apochromatic, oil immersion $\frac{1}{12}$, 1.25 N. A., is a magnificent thing.

Readers of THE MICROSCOPE have fallen into the bad habit of sending their Exchange notices on postal cards and tangled up with blots, interlineations, compliments, complaints, suggestions, requests and other items. These the Editor must translate and copy for the printer. Henceforth, those that use that Department, and cannot go to the slight trouble of writing letters and Exchanges on separate sheets must suffer the loss. Hereafter, all *postal card* Exchange notices will go into the waste basket. The Editor's cat now has charge of that Department, and she is utterly devoid of respect for anything except her own rights.

NEWS · FROM · THE · WORKERS ·

THE PATHOGENIC MOUTH-BACTERIA.—Dr. W. D. Miller is publishing in the *Dental Cosmos* a series of papers of great value and importance to every scientific reader, and especially to

every physician, on "The Human Mouth as a Focus of Infection." From the second of these articles this abstract is made.

Twenty-three distinct bacterial forms have been cultivated from the saliva on artificial media. These are mentioned with the number of times they have been observed and their effect when injected into mice, rabbits, etc. On account of the large number of different micro-organisms commonly found in the human mouth, it is with few exceptions absolutely impossible to arrive at any conclusion regarding the presence or absence of any particular kind by a simple microscopic examination. Cultures on agar-agar also often fail of their purpose, since many pathogenic mouth-bacteria do not grow on this culture medium, or they grow so slowly that they are soon overgrown and hidden by the more proliferous saprophytes of the mouth. Gelatine is still less adapted to the purpose. Consequently recourse must be had to the animal body for the purpose of isolating such pathogenic micro-organisms as may be present in the saliva at the time of the examination.

The person whose saliva was to be examined was always instructed to intermix the saliva, by rubbing with the tip of the tongue against the cheeks and gums, with dead epithelium or other films and deposits which are often found clinging to the mucous membrane, and constantly carry enormous numbers of organisms. One or two drops of this saliva was then injected into the abdominal cavity of a white mouse.

Of the one hundred and eleven mice thus operated upon, twenty-seven died within fifteen hours; twenty-two in from fifteen to twenty-four hours; eighteen in twenty-four to forty-eight hours; eighty in two to four days; nine in four to eight days; thirteen in eight to twenty days; four in twenty to forty days; ten being still healthy after the expiration of thirty days, were put down as having escaped infection. It is quite possible that one or the other of these ten, if kept longer under observation, would still have succumbed to the effects of the inoculation. The serous or sero-purulent exudation in the peritoneal cavity usually showed large masses of bacteria, among which certain forms appeared almost constantly. These were examined microscopically and are described in the article, with superb illustrations. They were also cultivated on agar-agar and on other nutrient media.

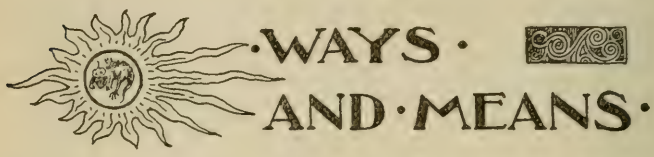
LUMINOUS BACTERIA.*—It would seem as if the influence of bacteria and micro-organisms generally upon higher forms of life was only just beginning to be understood. The researches of naturalists are constantly bringing new and unexpected facts to light. For instance, there is nothing better known than that phosphoresence is frequently exhibited by marine animals, especially by the crustacea. This phosphorescence is often infectious, that is, it can be communicated by touch. A French naturalist, M. Giard, has recently made known the results of some observations and experiments that he has been making with *Talitrus* and other marine crustacea On microscopically examining a brightly phosphorescent specimen which he found on the beach walking slowly instead of leaping as is its usual habit, he traced the phosporescent light to the presence of bacteria in its muscles, which were greatly altered. On inoculating other and healthy individuals of this and other species, the same disease was produced amongst them, and M. Giard says that his laboratory was quite lit up at night with these luminous but diseased crustacea. The inoculation was continued to the sixth generation apparently without any attenuation of the microbic action. The disease seems to follow a regular course, and the crustaceans die in three or four days. The phosphorescence, however, always lingered a few hours after death. Crabs were inoculated in the same way.

WHY THE EYELASHES ARE SOMETIMES SEEN IN THE EYE-PIECE.†—Meslin explains the reason why one sometimes sees in the bright circle of light in the microscope the image of his own eyelashes, inverted or erect, according to the kind of eye-piece used. The explanation lies in the fact that the lashes produce in the cone of light which proceeds from the mirror a shadow figure, the projection of which upon the retina depends on the focus of the rays issuing from the ocular. If these be a little convergent, or the eye be far enough from the ocular, the image will be thrown behind the retina; accordingly, a seemingly inverted image appears. In the reverse condition (strong convergence of the rays issuing from the ocular, or a near position

*Science Gossip.

†Journ. R. M. Soc. from Journ. de Phys.

of the eye), the image falls in front of the retina. The shadow figure originates in the prolongation of the rays diverging from the image, which is really inverted, but is perceived erect.



METHOD OF PREPARING DRY MICROSCOPIC PLANTS FOR THE MICROSCOPE.—G. Lagerheim* has found the following method convenient for examination of the Algæ or of other plants that have already been dried.

A fluid is prepared of the following composition: 1 part fused potassium hydrate is dissolved in 5 parts water, and when the solution is complete 5.5 parts are added of glycerine to the consistency of a syrup. The dried Desmids, Œdogoniaceæ, or other Algæ, are treated with water until they are thoroughly moist; a small piece of the material is then taken with fine forceps and placed upon the glass slide. One or two drops of the fluid are added, and the Algæ distributed as evenly as possible with dissecting needles. The slide is then warmed for a time over a spirit lamp and a cover glass finally placed on. The potassium hydrate has now caused the previously shrunken Algæ to swell and to resume their original form. The addition of glycerine gives consistency to the fluid, so that the Algæ can easily be turned over by shifting the cover class, and thus observed on different sides, a point of great importance, for example, in the study of the Desmids.

The Algæ prepared in this way can readily be drawn or measured. The cover glass is carefully removed, and, if a low power or a dissecting microscope is used, the object is taken up with a needle or stiff bristle, and again at once placed in potassium acetate or glycerine. If, on the contrary, the whole material thus prepared has to be got ready for drawing or measuring, a drop of acetic acid is added after removing the cover glass. The Algæ are in this way embedded in potassium acetate and

*Bot. Centralbl.—Cf. J. R. Micros. Soc.

glycerine, fluids perhaps the best adapted of any for the preservation of Algæ.

Dry mosses and fungi may also be prepared in the same way.

COAL ASHES.*—I do not know whether it is the same with coal from other districts, but I may say that our British coal ash forms a beautiful opaque object, and shows vegetable structure to perfection. To obtain a specimen take the white or yellow ash on the point of a dessert knife, then putting a pat of soft balsam on a slide, invert it over, and just touch the ash without squeezing it at all. Daylight is better than lamplight to investigate by.—*T. Inman.*

EVERY MICROSCOPIST should have fastened to his work table near the place upon which his microscope usually stands, a small pane of glass with one-half of the lower surface covered with black paper the other half with white. The paper need not be pasted to the glass, indeed it is better to have it unattached, the fastening of the pane to the table keeping the paper in place. The glass may be as large as desired, but 4x5 is a satisfactory size, according to the writer's notion. This simple arrangement will be found exceedingly useful in arranging objects on the slide, whether for temporary or for permanent preparation. Objects to be examined in a watch-glass with a pocket lens will be more readily seen if placed over the white or the black paper, as the necessities of the case may require.

A SIMPLE METHOD OF DRAWING microscopic objects, which will be found useful by those unable to employ the camera lucida, is to have a circle of thin glass ruled in squares, and dropped into the eye-piece so that the lines may be seen in the field and crossing the object; then by using sectional paper, that is, paper ruled in small squares, very good representations of what is seen may be reproduced. This manner of drawing is well known, but the way of making the lines on the glass is perhaps not so well understood. A piece of cover glass should be cemented to a glass slip and then coated with a thin layer of

*International Journ. of Micros.

paraffin, through which the lines required are to be ruled with a fine pointed needle. If then some finely powdered fluor-spar is put in a leaden or a platinum cup with some concentrated sulphuric acid, and the cover is placed over it, the lines will be acted upon by the hydrofluoric acid fumes and the glass will be etched accordingly. The cover glass should then be detached from the slip, cleaned and mounted on a circle of cardboard, but to a size to fit into the eye piece. In this way microscopical drawing becomes exceedingly easy, especially when the sectional paper is used.

A METHOD OF EQUALIZING THE THICKNESS OF SLIPS FOR USE WITH AN OIL IMMERSION CONDENSER.*—It is necessary that an oil immersion condenser should have a fairly long focus, otherwise it would be of no use if the slip happened to be rather thick. If the slip is thin it will be found impossible to keep the oil contact when the condenser is in focus, unless you increase the thickness of the slip by uniting a thick cover glass to the back by oil. It will be found very difficult to do this without oiling the stage when the microscope is inclined. The oil between the condenser and the cover glass is sure to unite with that between the cover glass and slip, and then the cover glass falls, upsetting the whole arrangement. I have found the following plan to answer admirably: A piece of glass one inch square, upon one side of which, close to the edge, a strip $\frac{1}{8}$ inch broad is fastened by shellac, is oiled to the back of the slip; the ledge hooking over the edge of the slide keeps it from slipping down.—*E. M. Nelson.*

STRUCTURE OF DIATOMS.—It having occurred to Mr. C. H. Gill* that if the markings were cavities they must have definite functions, and must be in connection with the interior cavity of the Diatom at least, probably filled with the living plasma of the organism, and further be in communication with the outside by other perforations in their exterior face. Then if the markings were cavities, they could be filled with foreign bodies, and if those bodies were opaque or deeply colored it would be easy to recognize their presence. After trying many different

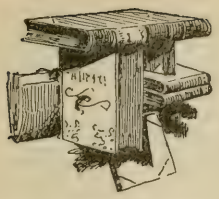
*Journ. Q. M. C.

methods, he found that precipitation of mercurous sulphide in situ was the best method of filling these cavities. If clean Diatoms are soaked in a solution of subnitrate of mercury till all their hollows are filled with it, and if they are then immersed in sulphide of ammonium, a double decomposition takes place, whereby black insoluble sulphide of mercury is produced and left in the minute cavities in which it is formed. Careful levigation with water will free the charged Diatoms from the greater part of the loose and unconfined sulphide, and leave them clean enough for examination. The process shows that in Diatoms of all classes the markings, whether secondary or primary, are due to the existence of holes or cavities in the substance of the test. Even the finest of the secondary markings can be filled with an opaque material.

Mr. Gill also writes to the *Journ. R. Micros. Soc.* on the same subject: When cleaned and dry Diatons are soaked in a concentrated solution of perchloride of iron for some time, all hollow spaces contained in the frustules become charged with the iron salt. If they be now transferred to an acid solution of potassium ferrocyanide, Prussian blue will be formed both outside and inside all hollows and cavities. On washing and levigating with water, the outside, unconfined portion of the precipitate can be washed away in great part, while those portions which are more or less surrounded by walls of silica remain in place, and serve to mark clearly the positions and limits of the spaces containing them.

Evaporating a solution of sodium platinum chloride on cleansed Diatoms, and igniting the whole with the addition of some crystals of oxalic acid, serves to charge the minute cavities with a deposit of spongy platinum.

Pinnulariæ under either of these treatments show their coarse ribbing to consist of ribbon-shaped tubes contained in the walls of the frustule. *Pleurosigma*, *Stauroneis*, *Cocconema*, etc., show their dots to be spaces which can be filled with foreign bodies. *Coscinodisci* have the openings into their lacunæ so large that the precipitates, for the most part, are washed out in the course of mounting, but the cell walls take so much of color that their shape and parts can be clearly distinguished.



NEW PUBLICATIONS

TABLES FOR DOCTOR AND DRUGGIST.—Compiled by Dr. Eli H. Long, 8 vo., pp. 133, Detroit: Geo. S. Davis. Price $2.00.—To be able to commend an author's work with no dash of adverse criticism, is a pleasure seldom felt by the reviewer, that must often appear either hypercritical or derelict of duty. But here there is no dilemma to trouble. The book is in every way praise-worthy and valuable, and it exactly fills a place that no other book has before even tried to fill. To many a doctor and many a druggist it will be a godsend. It contains a table of solubilities, the substances being arranged in alphabetical order, and their solubility given in water, in alcohol and in certain other solvents; a table of reactions and incompatibles; of doses and uses, in which is given the genitive case-ending of each substance, an arrangement that must be especially welcome to those doctors and druggists that are weak in their genitive; a table of specific gravities, and one of poisons and antidotes. There are few persons, whatever their profession or vocation, that can fail to find this book a valuable one to have within reach at any moment. From it may be had, at a single glance, information to be found elsewhere only after long and tedious search. It merits a wide circulation and much careful consulting.

BULLETIN NO. 78, N. J. AGRICULTURAL COLLEGE EXPERIMENT STATION. Destroy the Black Knot of Plum and Cherry Trees. An appeal.

ANNUAL REPORT OF THE CURATOR OF THE MUSEUM OF AMERICAN ARCHÆOLOGY in connection with the University of Pennsylvania.

THE COSCINODISCEÆ.—Notes on some unreliable critera of genera and species. J. D. Cox, LL.D. Reprint.

SIXTEENTH ANNUAL REPORT of the American Postal Microscopical Society. Troy, N. Y., 1891.

MUSCULAR ATROPHIES. A clinico-pathological study. Wm. Krauss, M. D. Reprint.

THE MICROSCOPE
AN ILLUSTRATED MONTHLY MAGAZINE.

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ORIGINAL COMMUNICATIONS

CONSCIOUSNESS IN PROTOPLASM;

AND THE BACTERIA OF GERMINATION, MICROCOCCUS GERMINATUS, N. S., WITH SOME OTHER NEW BACTERIA.

DR. HENRY SHIMER.

I.

THE idea that there is a sense-emotion of some kind in plants is not a new one. The sensitive plant, the continuity and streaming of protoplasm are guide boards pointing that way. Dr. Alfred C. Stokes, the Editor of THE MICROSCOPE, in two late and interesting editorial notes, has directed a line of thought, based on observations, to his readers, well worth more than the cost of his journal for years to come.

Let us repeat the experiment of his suggesting, and learn what we can from it. Now at ten P. M. the temperature of our work room is 69° F. Here we have had a sprouting onion for the last twenty-four hours, preparing it for work.

In the common onion bulb there is a very thin pellicle, a tissue-paper-like sheet between successive leaf layers or coats of

the bulb. We will cut through these outer layers in a radial direction with a sharp knife (for we will find it sensitive to wounds), in the form of a little square, half inch on a side, and remove the piece cut through, just as the boy plugs a watermelon, in his neighbor's melon patch. On the inside of this leaf-piece, or on the outside of the next, we find our film in good form to handle and to mount, and we carefully transfer it to a drop of water on a slide, and another drop on the cover glass will insure the mount to be free of air bubbles; it is all important that our section be taken from an onion that is growing and otherwise healthy, as we learn further along; this we have tried to do; it has a new green shoot more than an inch long, and we see no mould on it. I can hardly hope to give such definite directions as may enable others at sight to select the best onions for this work, for I have had much trouble to find them myself. A solid, plump little onion set, although beginning to shoot, did not afford my best specimens; large healthy onions, as gathered in Autumn from the field, and not yet shooting at all, were hardly to be considered very good; in both of these the protoplasm was very dimly seen. It was among the growing onions that were somewhat softened, yet not too much dried, that I found my best working material; these gave me the richest, best flowing and most conspicuous protoplasm; when the bulbs had wilted and dried, so that the films were adherent, they were useless, and worse when grayish. The film should separate easily and come off freely with a clear, watery appearance, to give any promise of usefulness; even then something may be wrong, and it fails us.

My experience with mould on the onion, even in small patches, was unfavorable; a section with but a few twigs of mycelium in one corner was worthless; the mould, in some way, either by shock from the injury it was doing or by poisoning, had killed the protoplasm in all the cells of the entire section. With a low or medium eye piece at the top of our tube (I prefer a "C" periscopic and a low power objective, say a half inch), we find our specimen made up of a single sheet of cells, that is, but one cell deep and joined together at the ends and sides by partition walls, a most admirable arrangement given us by nature for this study; no cut section can imitate it. The cells are very large; can be seen by the naked eye to be from half to three quarters

mm. long and narrower, being imperfect hexagons. The outer walls of these cells are thin, transparent membranes, and are well marked with lines, thickenings, wrinkles or folds, appearing much like the striæ figured by geologists for glacially scratched rocks; the partitions are thicker, averaging about 5μ thick, being more or less variable.

We observe that our little boxes — cells — are lined with a gelatinous substance, more dense than the clear cell sap within, therefore, visible as a distinct substance, although also transparent; this is the protoplasm; while this lines the walls of the cells the central portions are filled with the clear, limpid fluid, the plant or cell sap; by sectioning we may find the thick leaves of the bulb made up of cells like those in the film. We will carefully examine the mount with a first-class one-fifth or one-eighth objective. We very plainly see the protoplasm along the partition walls, much of it in the ends of the cells and an occasional band crossing through the cells, usually obliquely. We look in vain for the coveted streams; we see the granules trembling, vibrating and moving about in limited areas, but no currents; we examine the specimen all over from side to side, and through the middle we plainly see the protoplasmic jelly in every cell all in silence; we wait and watch; an hour has passed away, we begin to see here and there little signs of motion, but no streams. Why? What is the trouble? Our onion seemed to be one of the best; we are studying it in a temperature of 50°–70° F.; we wait and watch patiently and carefully; the midnight hour is here, we are at length rewarded with some streaming protoplasm in the perfect border cells, for in the wounded cells the protoplasm has already separated and rolled together in a mass in the middle, but it is in only one or two of the outer rows of cells that we find the protoplasm streaming, all the inner cells are yet nearly motionless; but weariness bids us retire for rest, so we place this slide in a damp box, *i. e.*, two tea saucers inverted together, a little water in the bottom, the slide supported on chips above it and thus leave it for future study.

In the morning we have an opportunity to take up the study of our specimen; the temperature of the damp box where it passed the night is now 45°; the protoplasm is streaming magnificently; we plainly see it with a half-inch, and it can be seen

with a one inch by lamp light aided by a condenser, as I have observed on former occasions when I knew just where to look for it. Applying the one-fifth we are rewarded by an indiscribably magnificent exhibition; the protoplasmic life currents are grandly astir; we see the protoplasm itself as plainly as streams of water after a shower, and in or on it are sharply defined granules, sweeping along in these currents, little globular bodies; without these the protoplasm is soft and beautiful, shining in its modified light as mildly as moonbeams pale. We have often observed this soft, pale appearance of healthy, growing protoplasm; with age it becomes denser, more easily seen, until at last, when it is dead, it is dense and very prominent. It then separates from the cell walls and rolls into a mass in the middle, appearing not much unlike the cumulus clouds of a summer afternoon. Along the cell partitions we usually observe the current of living protoplasm moving up along one side and in an opposite direction down the other, caused no doubt by the inter-communication of protoplasm from cell to cell, through openings that we will examine soon. The stream may often be narrow along the partition on one side, while on the other it is a broad stream, occasionally with thickened or swollen edges, or now moving in double currents like soldiers countermarching. Here and there a thick band crosses through the cell, oftenest obliquely; these, like grand highways, are select lines in which the streams of life are flowing. Now focusing through the upper plates of the cell, any one shows motion just within its wall; see those broad sheets of protoplasm pressing, streaming onward with some definite object in view; focus downward through the cells; here and there threads of streamers may be seen in some cells crossing through the middle interior, cellular spaces, but oftenest it is still and clear in these central areas of the sap reservoirs, as pure as water itself, even no special granules to be seen; focus down till we reach the protoplasm that lines the lower great flat plate of the cells; here we have a still better view of what we saw just beneath the upper cell walls; the streams are more definite, the granules are plainer and can be studied more satisfactorily; thus we trace the protoplasm on every wall of our little cell, and the sap within seems to be its feeder. We see the protoplasm itself, independent of these sharply defined granules, as we have often seen

the glorious milky way in the southern sky, in dry soft Summer nights of August and September, in these western lands.

We must now, however, break away from the thought of this wonderful vision and turn our attention to the partition walls themselves. They are rather thick, from 3 to 7μ across, somewhat irregular and uneven, separating the rays of light. See those rainbow colors; focus carefully where the broad side plates join the partition walls; we see narrow breaks in the top of the walls—gateways; we must investigate this still more carefully, so we will use a one-eighth immersion, and a Bausch & Lomb one-sixth, dry, first-class; if our cover is thin enough we will find the latter much the best for this work, as it gives the sharpest definition. The breaks we saw in the continuity of the tops of the partition walls are little openings from about 1 to 5μ wide, the floor of which narrows up to a sharp ridge; very likely it is thus on all sides of the opening if we could see it; this little, ridgy film may be a check valve; through these openings the protoplasmic streams are passing from cell to cell. We enjoy this view under the best possible light of an east window at 11 A. M., the clouds of a morning snow storm having so thinned that the sun almost shines through, and without the Abbe condenser, which is useful by lamp-light, but damaging in such light as we now have.

Twenty-four hours later we again take up the slide from the damp box. We plainly see the protoplasm as pale, light gray linings of the cell walls; there is no motion; the protoplasm is at rest in the sleep of apparent death, but as we shall find, may yet be revived; we warm the slide to 60°, but reaction does not appear. What we have seen reminds us of the so called surgical shock in man after a severe accident, a period of depressed vitality or inactivity of the life forces; whatever they may be, this is not caused by pain, for in great or sudden accidents pain is not a factor much complained of; it is not a symptom of injury of the great nerve centres, either, but seems simply to be a depression of the life forces on account of the injury to or loss of the continuity of a large part of the organism—a shock to its protoplasm, perhaps. In this study we have at first, after cutting the onion and making the slide, a period of quietude, of stillness, in the protoplasm, resembling shock in the animal organization and a recovery very like the recovery

from the surgical shock in man; the protoplasm in our section begins to move first in the cells adjacent to the cut; in the cut cells themselves the protoplasm never revives its activity, but lets go its attachment, and rolls into shapeless cloud-like masses in the inner areas of the cells, lying there still in the repose of death; they never revived during my observations prolonged through a full week. After nine hours I found the reaction in the protoplasm complete, exhibiting as grand a flowing as I ever saw; this was not brought about by warming the protoplasm; the temperature as noted above had fallen 15° or more; then the natural conclusion is that the reaction was brought about by some intrinsic cause wherein time was an important element, just as time is required to bring about recovery from surgical shock. This was not an isolated example, for I have repeatedly observed the same phenomena in sections from different onions, but in this slide we see that after twenty-four hours more (thirty-six after the sectioning) the protoplasm does not flow by warming it from 45° to 60°. We may venture to raise the temperature carefully a little higher, not very high, for I have stopped entirely a respectable flow by raising the heat up to 100°, endeavoring to get up a better exhibition in a somewhat sluggish specimen; we know that the onion grows best in a moderate temperature, that of early spring. By examining works on physiological botany, we learn that the germinating temperature best suiting seeds that grow in early spring is as low as 40°, and ceases at 88°–93°. Upon raising the temperature of our slide to 70° the protoplasmic streams are revived as beautifully as before, but on the following day, sixty hours after mounting, we failed to persuade the protoplasm to flow, although we raised the temperature to 80°; we continue to try it on other days, always with failures, until on the sixth we had allowed the specimen to dry so far that the air had entered under the section; by applying water under the cover and warming, we got a flow of the protoplasm, possibly this time through osmosis rather than life.

Next day, the seventh after mounting, we examine the specimen at 60°; no life; raise it to 80°; no flow. The specific principle of germination is almost entirely quiet; here and there on the partition walls we observe a few large cells much like mould spores; at 90°, using the thermometer all the

time, the protoplasm still refuses to flow, while other newer mounts respond to the same treatment. In all these experiments great carefulness is needed; slides and covers cleaned with alcohol or other chemicals should not be used. I, therefore, have concluded to clean them as well as I can with pure water, mount the specimens in clear or filtered rain water and examine at once; if the protoplasm is healthy and attached to the cell walls, place it in a damp box, hoping in a little time, from one to ten hours, to see the flow, but if the protoplasm is separated from the cell wall, or is too yellow and coarsely granular or bubbly, it is dead or dying and worthless; we, therefore, throw it away without further coaxing. I have not yet entirely decided whether the above described phenomena of shock to the protoplasm was entirely caused by cutting and wounding its continuity, or whether in part it might be due to the mounting, but I am strongly inclined to the former view.

Apparently living onions with living shoots, from an outhouse loft without fire, where the temperature must often fall to 25° or 20°, and occasionally to 15° or 10° during the winter, present various themes for study. A mount from one at 35°, worked in a temperature of 50°, a very few cells exhibited the protoplasmic flow at once; in an hour the temperature had risen to 65°, when I hoped to see a general flow, but the cells were quiet and I saw no living bacteria of germination. The cells were about dying and were full of little circles, evidently gas bubbles pushing the protoplasmic granules into moraine like masses on their circumference. Here and there a cell in good condition was streaming beautifully. In this case the cells were nearly all dead. There was not that evidence of shock that we saw where the continuity of the protoplasm was complete; some others of these sprouting onions are further on in the decline and show the elements of decay more positively. The *bacterium refringente* and the *micrococcus giganteus* described further on, are beginning to appear on the outside of the cells; they are often carried along by the water currents, formed by drying out at the edges of the cover. These coarse granules are very easily seen, and when thus floated along in the water current are very likely to be mistaken by the inexperienced for the flow of the protoplasm, and very surely so if he has not learned to know where he is focusing, whether on

the outside or the inside of the cells. Another sound onion from the grocery, never frozen, from which I cut a section a week ago, has dead, separated protoplasm in the cells of a section which I now make, a long distance from where I plugged it for the former section. Such sections as I first described are not readily obtained; I found only a few among a great number of trials. I am now placing a number of bulbs in shallow dishes of water, hoping to meet with more uniform success. Planting in soil in boxes would be a still more promising method of preparation.

FLOATING PARTICLES IN THE EYE, A SOURCE OF ERROR IN MICROSCOPICAL OBSERVATION.

LUCIEN HOWE, M. D., F. R. M. S.

READ BEFORE THE AM. MICROS. SOC.

AT THE meeting of the American Society of Microscopists, held at Cleveland, I had the honor of demonstrating the fact that irregularity in the curvature of the cornea, which is almost constantly present in the human eye, interferes materially with certain microscopical work. This irregularity, known technically as astigmatism, frequently prevents one person from seeing fine lines, for example, those of the Nobert plate, or Diatom striæ, when these are placed in one direction, but they may be seen by another person in that position, or indeed by the same individual, if the position of the lines be somewhat altered. It was gratifying to see that the subject was of sufficient value to call forth one or two other articles in microscopical journals, corroborating the observation, and I think there is now no doubt that the existence of astigmatism must be regarded as a decided obstacle to the proper observation of certain tests by individuals who possess this peculiarity in any decided degree, and observation shows that in 96 or 98 per cent. this condition exists in a sufficient degree to be measured by a suitable instrument, called the ophthalmometer.

In the present short paper I wish to call attention to the fact that there exists in the eyes of almost every individual still another imperfection sufficient to cause a faulty observation, when looking at another class of objects.

It is a well-known fact that in the vitreous humor, a semi-gelatinous mass, filling up the greater part of the posterior portion of the eye, there are frequently floating small particles, which are known to oculists as "muscæ volitantes."

The origin of this imperfection does not concern us here; it is only of interest to know that, though existing practically in almost every eye, ordinarily they are not visible, just as the dust in a room is not visible when the light enters through the widely open windows, and is equally diffused throughout the room; but if a beam of sunlight enters through a small opening in the shutter, then innumerable objects are seen dancing in the tract of the beam, not only reflecting the rays, but casting shadows behind them. So it is possible for almost any individual to see the small particles in the vitreous humor of his own eye. For this purpose it is necessary, however, to allow the light to enter it, not through the widely opened pupil, but through a small aperture (for example, by pricking a pin hole in a card and looking through at the sun, or at some other source of very bright light.) When this is done, the beam illuminates the particles which may be in the vitreous humor so strongly that they throw a shadow on the retina, and thus become visible.

The form of these particles varies considerably. Usually they are in the form of fine dots, more or less well defined, and occasionally these dots have such sharp edges and are so well marked or perfectly stationary that they can well be confused with certain microscopical objects which we shall consider presently.

Again several of these dots are joined in the form of a chain, or still again, several chains or particles may move together. These are the appearances most frequently observed.

Now as to the application of this pathological, or, practically, physiological, fact to the use of the microscope. Let us see what the connection is. We have the same optical conditions, especially when high powers are used. The ray of light is a small one, as it comes through the small opening in the diaphragm, and must necessarily be as strong as possible. Then again the reason for using high powers is to observe more exactly exceedingly fine objects, and one of the branches of microscopical work in which these particles in the vitreous are

most apt to give rise to mistakes is in the study of bacteriological forms. One fully conversant with the varieties and structure of bacteria, would not be apt, it is true, to confuse these imperfections in their own eyes with what might be actually under the microscope, but I not only know of this mistake having been made by those who are not without experience in bacteriological work, but it is not impossible for the same to occur to many whose observation has not been sharpened by long practice in the use of the microscope. I feel confident that, out of a dozen persons who make the drawings of what they see of such numerous, ill-defined objects, there would be two or three who would figure what is not in the field of vision, but an imperfection which actually exists in their own eyes.

ELEMENTARY MICROSCOPICAL MOUNTING.—II.

DR. A. M. WEBSTER.

THE THIN GLASS COVER.

THE thin glass is used, except in some very rare cases, as a cover to all mounts of microscopical objects. These rare instances will be referred to hereafter. The purpose of the thin cover is at least fourfold. It is really a cover to protect the object beneath from dust and from accident, and it may be used and often is used as a means of marking the position of the minute object beneath it, so that another microscopist, to whom the slide may be sent, can easily and rapidly find that object and see what his friend at a distance has seen. This is done by finding the object, or a special part of it, with a low power, and then placing on each side, but on the upper surface of the cover glass, a minute ink spot. The friend to whom it may then be sent will need only to put the preparation under his microscope and find the ink spots, when he will have the object in or near the position desired by him that sent it. But this is not the chief purpose of the cover. It is only one of those things that have suggested themselves after the cover had been applied with other aims and for other reasons.

As a rule objects are mounted in liquid preservative media, or in substances that are fluid when first used. There are

exceptions to this, as we shall see, but it is the rule, and the cover glass brings into play the important law of Nature called capillary attraction. The narrow space between it and the slip below is filled with the mounting fluid and is held in place, in part at least, by capillary attraction. If it was not for this useful law of Nature we should not be able to immerse our microscopical objects in any preservative media except those that are solid or capable of becoming solid. Such media are used and are exceedingly valuable. Canada balsam is one of them. It will be referred to extensively hereafter.

A more important function of the cover glass, yet not the most valuable, is to protect the front lens of the objective. Some objectives have so great a magnifying power that to focus them they must be brought uncomfortably close to the object to be examined, uncomfortably close, that is, for the microscopist that is then always in great anxiety lest the front lens of his objective should come in contact with the cover, and be scratched or perhaps broken. The microscopist is always careful to avoid this, for an objective with a scratch on the front lens may be a ruined objective; if the front lens is broken it will certainly be ruined beyond repair. If there was no thin film of glass above the object, the difficulty in using high power objectives, or indeed any kind of microscope lenses, would be greatly increased. It would be exceedingly awkward to have the object sticking to the front lens when it was racked upward; and if it happened to be hard or gritty it might do great harm. Without the cover glass certain kinds of objectives could not be used, and the microscopist would thus be forced to do without some of the most important aids to investigation that the optician has given him. These are immersion objectives, with which a drop of water or of oil or of a liquid formed of a combination of various substances, is placed between the front of the objective and the top of the cover glass. These objectives are the finest and most valuable that the working microscopist has; without them he would be limited to the use of what are called dry objectives, or those that are used with air only between them and the cover above the object. All low power objectives are dry, as are many high powers, but the best of the latter kind are made on a principle rather different from the dry lenses and are worthless without the water or other liquid between their front and the

cover. The cover therefore protects the objective with its drop of immersion fluid, and it protects also the object from the action of that fluid.

But among all these important functions perhaps the most important is to flatten the drop of medium in which the object is embedded. When this mounting fluid is placed on the object as it lies upon the slip, it acts as a drop of liquid will always act. It would form a spherical drop if the slip itself did not flatten out the lower side; but as well as it can it follows the law of Nature that commands every free drop to become a sphere, and forms its upper surface into a curve that is that of a hemisphere since its lower surface is flattened. Now this liquid hemisphere has a very unwelcome action on the light that passes through it from the mirror below the stage of the microscope. The action is optically so peculiar and therefore so unwelcome, that the object can scarcely be seen, acquiring a very strange appearance by being puckered and distorted in a way that would lead the microscopist to erroneous opinions as to its character and structure, if there was no way to get rid of this hemispherical drop that is the cause of the mischief. When the drop is flattened, the light will pass through it without giving the microscopist these optical troubles, and to flatten it he uses the film of thin glass called the cover, an exceedingly important little contrivance, and one with which the beginner in mounting will have the severest struggles before he conquers it. But it is tractable when once mastered, and the process of getting it into subjection is not very great; it needs only some care and some intelligent attention. In this it is like all things connected with the microscope. At first the whole instrument will be rebellious, and the beginner may be discouraged; but a little intelligent application of an intelligent mind to a piece of inanimate matter will meet with success, and the instrument will soon become a helpful companion and an entertaining one.

At first the absence of thickness in cover glasses and the facility with which they break are surprising; and a broken cover is good only to be thrown away. At the beginning, too, the novice at mounting will break about every alternate cover that he touches, until he thinks that his experience is exceptional; but it is not. Everybody passes through this breaking stage. It is of only short duration; the worker soon learns to

handle the thinnest of glass, and to do it with apparent carelessness, but in reality with the skill born of practice.

The glass is to be obtained from the dealers in microscopical supplies, and comes in three thicknesses, being ordered according to the number, the number rising as the thickness increases. Number 1 is the thinnest, with the exception of that which is specially measured and used for special purposes. The thickness of No. 1 is from 1-150 to 1-200 inch; that of No. 2 from 1-100 to 1-150; and of No. 3, from 1-50 to 1-100. The thickness varies within these limits in almost every lot sent out by the dealers. No. 3, the thickest, should not be used for any purpose. It is entirely too thick for any but opaque objects to be examined with very low powers, yet I should recommend the beginner not to buy it for any purpose. It is much better to use one thickness for every object, so that all the preparations in the cabinet may be examined with high powers, if necessary. A mount prepared for a high power objective is as useful for a low power, provided, of course, it can be appropriately studied with that power. Some objects, as the reader knows, can be examined with high powers only; but this does not invalidate the advice always to use one thickness of cover glass, and to have it as thin as convenient. No. 2, from 1-100 to 1-150 inch, is the proper glass to select and to use for most objects. The facility of handling and manipulating it is soon acquired, and the advantages to be gained are important. No. 1, from 1-150 to 1-200, is too thin for ordinary use. It is intended only for those very high powers employed by microscopical experts in original investigations.

The glass can be obtained in squares and circles, both kinds being sold by the ounce or by the dozen pieces. For mounting purposes the circles are the best, because the finished slide presents a better appearance with a neatly formed disk in the centre than with a square. This is, however, the least important reason. Most mounts have a ring of cement placed around the edge of the cover in order to keep the enclosed fluid and object in place, and to prevent the evaporation of the mounting medium. With the contrivance called a turn table, to be referred to hereafter, a ring of cement can be neatly and rapidly spun about the cover's margin; with a square cover the applying of the finishing cement is more difficult and the result

much less attractive in appearance. For temporary study of an object, when it is placed on the slip with a drop of water and studied, but not permanently mounted by the fastening down of the cover, thin squares are much more convenient as they are pleasanter to handle, easier to be cleaned after use, and rather cheaper, although the question of cheapness in cover glass is a small one, since it is all inexpensive, and fortunately so for the microscopist. If covers were as costly as they are fragile we should be in an unenviable position.

The circles may be had in various sizes from 3-16ths of an inch in diameter up to $\frac{3}{4}$ inch, and larger if desired and ordered to be so cut. But as a rule the diameter increases by sixteenths of an inch. The smallest sizes are not adapted to general use; they are intended for special purposes, when the microscopist desires to mount a single very small object, a single Diatom, for instance. The largest sizes are also designed for special purposes, such as very broad sections of animal tissues, or some other large object that cannot be conveniently divided into smaller portions. The most acceptable size for general mounting is $\frac{5}{8}$ inch, or perhaps 11-16; but the reader should remember that the larger the disk the more easily it is broken.

Thin squares may be had from $\frac{1}{2}$ to $\frac{3}{4}$ inches square. The smaller size is not to be commended. The $\frac{3}{4}$ inch the reader will find the appropriate one, either for permanent mounting or for the study of an unmounted specimen that is not to be preserved in the cabinet.

But thin covers also come from the dealers in any but a clean condition. If they should be used in the state in which they are bought the object would be obscured and the examination be made very unsatisfactory. They must be carefully cleaned before they can be used. This is a process demanding rather more care than the cleaning of slips. Yet all that is needed is practice. The thinnest covers can be as easily and as successfully cleaned by rubbing them between two folds of a clean and soft old cloth as can the ordinary slip. And usually this is all that they need. They are never excessively dirty when they come from the dealer, and a gentle application of the soft old rag held between the thumb and finger is generally all that is needed. About the only precaution to be remembered when using this method is to have the cloth perfectly smooth. If it

is wrinkled the unequal pressure will certainly break the fragile things. Take the cover between the two folds of the cloth and between the thumb and finger, and gently rub it while it is steadied with the left hand. When one side has been polished, turn it over and repeat the performance.

Many mechanical devices have been devised and recommended for this purpose, but, except with the very thinnest glass they are not necessary. The simplest and most useful of these is made of two flat wooden blocks, with a surface tightly covered with thick, soft chamois skin fastened on with tacks around the sides and where they cannot come in contact with the glass. A cover is placed on the chamois skin and the soft chamois skin surface of the other block placed above it, when the glass is rubbed between them, and so cleaned. When one side is polished, turn the blocks over and clean the other side by the same movements. With this simple apparatus it is hardly possible to break the thinest of covers. If the rubbing leaves them imperfectly polished the application of a little saliva will have a good effect. Some microscopists place their covers in water and sulphuric acid, washing them afterward in pure water and wiping on a soft rag. This is seldom necessary. Sulphuric acid and water should be mixed with exceedingly great caution, as so much heat is generated suddenly that disastrous results may follow. It is better not to use it, unless you have a laboratory to work in, or unless you are somewhat of a chemist. Pure water, a little saliva and an old rag are all that are commonly needed.

When once cleaned they should be kept so. To do this it is only necessary to protect them from the dust and from handling. A touch of the finger will soil a thin cover, so that it will be unfit for mounting. Microscopists have also devised special boxes to hold cleaned covers, but unless the worker is doing much mounting and wants the covers in abundance and within easy reach, these are not necessary. Wooden blocks have been suggested, in which longitudinal grooves have been cut, the covers to be placed obliquely in the furrows, so that they may be readily picked out by the forceps. Nothing more, however, is needed than a dust-tight box lined loosely with one or two layers of Japanese filter-paper. This paper is used extensively by the dentists and can be had cheaply from the dealers in

dental supplies. It is soft and without grit in its substance. It is exceedingly useful not only for cleaning and protecting cover glasses, but for wiping the lenses and the eye-pieces of the microscope.

Dr. F. L. James, in his "Microscopical Technology," suggests a cover glass holder made by placing around a cork or some other circular object, a coil of brass or of copper bell-spring, the ends of the wire being thrust into the cork to hold it firmly in place, and the cork with its burden of spring is fastened to a heavy base. The cleaned covers are inserted into the spring, as Dr. James remarks, much as a pen holder is inserted into similar spring-racks. The whole is then protected from the dust, and the covers remain clean and are conveniently reached when wanted.

MORE ABOUT CEMENTS.—II.

J. D. BECK.

BY mixing plenty of moist Chinese white with the colorless cement, and grinding it thoroughly in a mortar and placing it in a bottle with a sufficient quantity of glycerine to prevent cracking, you will have a beautiful and durable white cement. On a fair trial it will be found that these cements will have no equal for durability and tenacity on glass, and that they will not run into balsam mounts if the latter are sufficiently hard for any cement which dries quickly.

It will be necessary to give the rings made of these cements several coats of amber varnish or the best copal varnish, so as to resist moisture. I do not recommend these colored cements for aqueous mounts lest they run in. Balsam, gelatine or gum mounts, when neatly finished with the following transparent cements are unequaled in beauty, and probably as durable as any; they never ruin any mounts by running in, and save the time consumed in ornamenting, which really adds no essential value to slides. Procure a good colorless amber, or best colorless copal varnish, and add a little white beeswax to one bottle of amber or of copal varnish or palmitate of alumina* instead of wax, and it will increase the tenacity and elasticity of the cements which are to be used for the body of the ring around moist or

*Dissolve in oil of turpentine.

aqueous mounts, while the last, or last two coats, should be as hard as possible; they will adhere to softer coatings, while they might be too brittle to apply directly to the glass.

Good gold size has only one fault—it dries too slowly. The best copal varnishes are just as good and dry in much less time. I abhor all fluid mounts, and, therefore, have no use for that miserable, brittle, crumbling white zinc cement which soon assumes a dirty, mud color.

When glass can be prepared to inclose an object in fluid and be as durable as the cells or tubes of spirit levels, or bulbs of thermometers, with a vacuum chamber (for expansion and contraction) at one side, and not interfere with objectives, then I may turn my attention to fluid media, but not till that is a success.

For anhydrous cements I proceed as follows:

1. Give the balsam mounts a coat of good, pale copal varnish as wide as the ring is to be. Good "Elastic Gear Varnish" is so tenacious and elastic that I have used polished steel tools (with only one coat of it) for over twenty years, it effectually protecting them from rust.

2. Revolve the slide on the turn table and scrape or rub and polish the surface a little before applying the second coat; unless this is done the air or gloss will cause some trouble before the next coat will adhere to the surface. This operation requires care and skill.

3. Build up or fill up the ring around the cover glass, or, for a cell, use the same varnish with a little white beeswax dissolved with it, and thinned with turpentine or benzol, if too thick. Put on thin coats and give each coat plenty of time to dry and harden, so that it may be scraped or polished; it requires very little friction on the surface to make the next coat adhere. I prefer a small, sharp chisel, which can be made of a brad awl or selected from engravers' tools. I have sometimes used a small stick with its end properly dressed and dipped in cold water and pulverized pumice stone, which is then washed away, but I like the chisel best.

4. Apply one or two coats of ivory black mixed with a little varnish; when dry and hard, polish with a scraper, cold water and pumice stone, or any suitable polishing material.

5. Wash with cold water and a soft brush; wipe dry with soft chamois skin or linen rag.

6. Apply an even coat of good amber or copal varnish. I find good copal varnish, called "Elastic Gear Varnish," and used on carriage gearing, better than any gold size. It has to go through mud, rain, sand, the burning sun, expansion of heat and contraction of cold, on carriages and railroad passenger cars. The body of the ring should be hard, solid, tough, elastic, and above all, devoid of brittleness; it should be built up to the top of the cover glass and finished with the best amber or copal varnish.

To make a colorless copal varnish select the palest lumps of copal gum and crush them into small pieces, but do not pulverize when full of dirt; tie in a bag of fine muslin, and suspend in a wide mouth bottle of sulphuric ether, when the copal will gradually ooze out into the ether. When the gum has been digested, let the bag drain off and be thrown into another bottle of ether, which will remove all the available gum. It is a good plan to have plenty of the gum so that the liquid will form a varnish sufficiently thick. Then add oil of caraway or any slow drying essential oil, as oil of anise or poppy or sweet almonds, which are as colorless as possible in such small quantities; this will make the varnish dry more slowly and render it more elastic. When it dries properly, yet is too thick, add oil of rosemary or some such colorless essential oil that it may dry about as fast as may be required. If it should dry too slowly add more ether and mix thoroughly.

Some of the essential oils, although colorless, have slightly colored my varnish, yet it is the most colorless varnish I ever saw. It is elastic, dries hard and endures the test admirably, and is very tenacious; it is easily prepared in the way described.

A Russian physician has succeeded in cultivating vaccine virus, and finds that the virus, artificially cultivated, is as effective as the genuine, and has the advantage of absolute purity, so that its use involves no danger from scrofula, tuberculosis, or other constitutional diseases.—*The Pacific Rec. Md. and Surg.*

Prof. Christopher Johnson, a well-known microscopist, died in Baltimore, Oct. 11th, aged sixty-nine years.

"You say that you can neither read nor write?" the Chancellor asked the witness. "I said so." "How do you get a living?" "I scrub, wash, tend killin's, spin wool, and do such things." It was pitiful, yet it was inspiring. The poor woman had met the angel at the cross-road and had touched his hand. That was the comfort in it.

The angel is always at the cross-roads. He may take the form of a knight in shining armor, or only that of a sign-post; he may be a veritable cherub with a halo, or only a mile-stone in the sun; yet he is there. His name? Go-Ahead-and-Help-Yourself is his name. If you trudge through the dust and the mire of the highway to the fork in the road, there help will come in the shape of a sign-board, perhaps; always in a shortened distance remaining.

It might be well for some microscopists to remember the angel at the cross-roads, and go to meet him. To use the instrument for anything but the merest amusement is not a light task. It demands care, and much study, and delicate perceptions, and cultivated eyes, and precision of movement, and steady nerves, and healthy brain, and willingness to work like a galley-slave, and love of Nature, and an acquaintance with the angel at the cross-roads. Does it pay? Said Jeffries Wyman, "I think that the most happy and heart-filling thing in the world is to come face to face with something which no one but God ever saw before."

Many beginners go to the microscope without an understanding of the necessary conditions. They seem to forget that to conquer anything means hard work. The depravity of inanimate things is appalling, but they can be reformed. The microscope will at first seem to pull one way, while its owner is tugging the other. The mirror, with fiendish glee, will refuse to reflect the light anywhere. Thin covers will smash themselves. The water drops will run out of the cell and trickle down the stage. The pinions will get loose and the body will slip. Every-

thing will go wrong, and the microscopist, unless he be persistent and willing to help himself to the cross-roads, will put aside the instrument and feel that he has been deluded, and that all microscopists are in league to conceal their own failure. The trouble is that he has expected an inanimate thing to lead him, whereas he must lead it. Let him creep and stagger, and drag the microscope along till he gets to the first cross-roads, and if the angel should happen to be absent he will not be missed, for the microscopist, by that time, will have learned something. His muscles have become so steady that the mirror is conquered; he will handle thin glass with seemingly careless ease; he will now begin to catch glimpses of something in the microscopical highway, and once there he may come face to face with Jeffries Wyman's heart-filling experience; he will surely find the angel then.

Others help those who help themselves, it is said, and the microscopist soon discovers the truth of that. There can be no less selfish class of human beings than the class of the microscopists. But to cry and whine and mope and then give up, because the whole universe does not stand still at your wish, and the whole army of microscopists does not rush back to lift you up, is no way to get help. The editor of the *Druggist's Circular* has put the matter in this pungent shape:

"Relying on the help of others to the exclusion of individual exertion is not the way to learn. He who gives evidence of having exhausted his powers of direct inquiry will always receive the cheerfully given aid of others more experienced, and aid so acquired will be of far more value on account of the previous preparation by research than it would be without such effort. Information gained by labor is apt to be remembered, and a man's fund of available knowledge will always be in proportion to the thought and work expended in its acquirement."

Only show a willingness to help yourself, and any one of the great army of investigators will gladly turn back to lend a hand when asked. If he should refuse, set him down for a fraud and a mountebank. There is no more subtle test of a true microscopist than the asking for microscopical help. The beginner himself will soon feel the promptings of the microscopical philanthropy, and will actually be on the look out for

some unhappy, stumbling creature whom he may take by the hand and introduce to the angel at the cross roads. It is possible that, for a while, even he will be helped who is so helpless that he can only lean against the fence and cry aloud to the passers by: "Tell me what to study, and how to get the material, and how to prepare it, and what to look for when it is under the microscope." Even he will be looked after if he will show his willingness to make obeisance to the angel at the cross roads.

In the Christmas number of a popular magazine Mark Twain writes a suggestive article in which he claims, with much plausible evidence, that what he calls mental telegraphy exists and can almost at will be put into action between two persons remote from each other. That there is some truth in the assertion is the experience of every one, but that the faculty, if it may be called so, can be exercised to the extent claimed by Mr. Clemmens is scarcely believable. But to recommend the reading of the paper or the making of experiments in mental telegraphy are not my present purpose. Yet there seems to have been some kind of modified mental influence at work between the inventors of microscopical lamps and THE MICROSCOPE, for I have within a short time received for examination two lamps for microscopical use, from two widely separated inventors, and made upon two widely separated patterns. The one was recently referred to as Mr. G. C. Taylor's diaphragm lamp, the other and newer production is a beautiful illuminator from Messrs. James Stratton & Son, of Brooklyn, N. Y.

In design, general appearance and finish the Stratton lamp is superior to any of the less complicated and less expensive forms that I have seen. And its effects, its convenient arrangement of parts and its ease of manipulation are in no way inferior to its graceful aspect. The oil reservoir carries a half-inch wick, and to prevent the radiation of light to the eye, is surmounted by a metal jacket which bears at the top a movable extension to intercept all reflection from the chimney. A well blackened, conical extension directs the rays to a bull's eye and also prevents any escape of light to annoy the worker or to dazzle his unoccupied eye. The entire metal part is capable of

rotation about the flame, or the oil reservoir itself can be rotated so that the edge of the flame may be utilized, an advantage which no microscopist would willingly abandon after experiencing its benefits, and the entire lamp may be adjusted to any height or angle of inclination at almost a touch. It is also provided with blue and ground glass to modify the illumination, which is again modified by a bull's eye nearly three inches in diameter. The draft is ample, and the light steady and easily manageable. One of the most acceptable features is that excellent effects of oblique light may be obtained without altering the position of the mirror or the sub-stage condenser. This is an acceptable gift to the microscopist with a diatom on the stage, as he can so easily examine it under oblique light without putting himself to the trouble of changing the place of the mirror or of the condenser, and without losing the influence of the sub-stage accessory. The effects are obtained by rotating the oil reservoir and of course the flame, the position of the bull's eye remaining unchanged. The complete separation of the bull's eye from the other parts of the lamp, while it is still held firmly in place and in focus, will be appreciated after a single trial, as it enables the microscopist to use it or to turn the lamp around and take the light direct from the flame in almost any position, the whole procedure being performed without a touch of the mirror or of the sub-stage arrangements. With one hand the microscopist is able to turn the lamp exclusive of the bull's eye, and thus watch, through the instrument, the effects of the oblique light and of its withdrawal. By turning the whole lamp on its heavy base and rotating the oil reservoir, the effects of illumination without the bull's eye may be had, while with the finger on the metal jacket the flame may be rotated so that the edge or the broad side may be used and their effects studied. The new lamp is not only an ornament to the work table, but it must be an acceptable acquisition to the working microscopist. Effects may be readily obtained with it that with other microscopical lamps must be had with considerable trouble or not at all.

ACKNOWLEDGMENT.—To Mr. Geo. Rust for a slide of fossil diatoms from Denver.

NEWS · FROM · THE · WORKERS ·

THE NEW "COLOR PHOTOGRAPHY."—(Process patented by F. E. Ives, July 22d, 1890.) The process consists in first making three photographs to represent the effect of the object photographed upon the three fundamental color-sensations (in accordance with the theory of color-vision now accepted by all scientists), and then combining these photographs by superposition, either by projection with a triple magic lantern, or in transparent gelatine prints. The three negatives are made from the same point of view, and by simultaneous and equal exposure on a single sensitive plate, the operation involving no more trouble or expense than the production of an ordinary negative. The lantern positives are made in the ordinary way, and projected with a single source of light, in an ordinary magic lantern, by simply replacing the ordinary projecting lens with a special front, so that the color-photographs can be interspersed among ordinary lantern pictures without causing any delays.

Composite heliochromy may be said to have grown out of a suggestion made by Henry Collin, Queen Victoria's painting-master, in 1865, and afterward improved upon and carried out imperfectly by Ducos Duhauron and others, but made successful only by Ives' discovery and application of a new principle, and rendered easy and commercially practicable by his invention of special optical devices. A history of the subject and detailed explanation of the process was published in the *Journal of the Franklin Institute*, January, 1891.

In view of the results now shown, Mr. Ives submits the proposition that photography is no longer subject to the reproach that it is incapable of reproducing the natural colors.

TROUT PARASITE OF THE YELLOWSTONE PARK.*—The lake trout in Yellowstone Park are infested with worms, concerning which

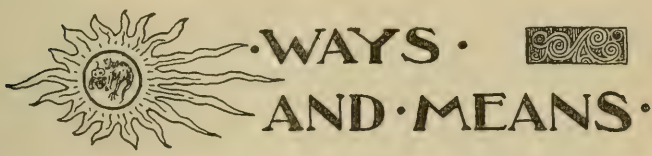
* Editorial note, N. Y. Med. Journ.

an interesting paragraph appears in the last annual report of Secretary Noble, of the Interior Department. The waters of the Yellowstone region were visited recently by Prof. Edwin Linton, who, in conjunction with Prof. S. A. Forbes, has reported informally concerning the probable nature of the trout parasite. These investigators believe that the parasite will be found to be a larval, or immature and non-sexual, form of animal life, resembling the "measles" stage of *Tænia solium* in the swine. In other words, this trout parasite is an example of that order of worms which complete the cycle of their life in two different animals. Having this hypothesis in view, Prof. Linton began a search for some form of animal which, by feeding upon the trout in a raw condition, would be likely to become the host of a sexually mature intestinal worm corresponding to the cystic and larval stage observed in the trout. He examined a number of the fish-eating birds occurring in the vicinity of the Yellowstone Lake, and finally hit upon the pelican as the probable final host in this alternation of generation. The pelican was found to have an intestinal parasite which had eggs and which appeared to belong to the same genus as the form in the trout. Collateral proof was obtained by opening the stomachs of some of these birds and finding therein ingesta of trout. These birds, four in number, were shot at Molly Island, in the southerly part of the lake, a favorite breeding-place to which the birds resort in great numbers. The pelican is, moreover, the only fish-eating bird that occurs on the lake in large numbers. It is understood that this bird consumes the fish of every description that happens to be left dead on the shores of the lake. The worm-infested trout is believed to be confined to a very limited and well-defined region of the waters. Mr. Linton's research was conducted with only an imperfect supply of appliances, and he expects to make a more careful examination of the materials he was able to collect and bring home.

Appropriate to this item is the fact that it was reported some months since that the trout of Loch Katrine, in Scotland, were infested with the tape-worm parasite or larva, and a certain amount of "scare" was created in the district which takes its drinking-water from that Loch, lest the citizens should serve as the unwilling host for maturing the incomplete tænia, and lest an "epidemic" of tape-worm might occur. Our impression is

that this anxiety was set at rest by showing, as some of the investigators had the means of doing, that tænial disease happened to be less frequent among the city folk supplied from the Loch than among the country residents who had their independent water supplies. And, further, the thought suggests itself that the parasite may not have been the *Tænia solium* after all, although resembling it, and it may have been, perchance, the same animal, whose life-history Mr. Linton has partially set forth in the *fontes et fauna* of our far West.

One peculiarity of the Yellowstone Lake trout not mentioned above is that the larval parasite may occur in the same fish of very different sizes, from that of a small cyst not larger than a small-sized shot, to that of larvæ that grow in the muscular tissue to be several inches in length.



TO SEE THE MARKINGS ON WOOL FIBRES.*—To make these characteristic markings more prominent, so that they may be readily studied, the fibre under examination must be treated to reduce its transparency and slightly spread the scales upon which the markings depend. To this end the fibre must first be cleansed and freed from the natural grease with which it is covered. This operation also effects the desired slight displacement of the scales. The material to be used for this purpose is a solution of silver nitrate in the strongest water of ammonia. The fibre, without any previous treatment, should be immersed in this solution directly, and after sufficiently long digestion, removed and dried, either by exposing it to sunlight or by heating on the drying plate. This whole treatment causes the fibre to swell somewhat, but the distortion occurring is more than counterbalanced by the results obtained. All the transverse markings showing the form and arrangement of the scales may be easily seen. The mounting medium is, however,

* Report upon an examination of wools.

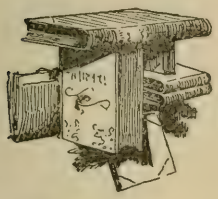
important. A mixture of equal parts of glycerine and of alcohol will give by far the most satisfactory result.—*Dr. W. McMurtrie.*

OIL OF ANISE.—This oil freezes at 50° F., and then makes a most beautiful polariscope object. Thaw the oil, place a drop on a glass slide and allow it to freeze, which it soon does, then view it under a thin glass cover without selenite. As soon as the oil begins to melt again, lovely forms of the brightest and most varied colors will be seen in motion in the field, their colors ever changing as their position changes with respect to the plane of polarisation.—*Scientific Enquirer.*

TO OBTAIN MICROSCOPIC FUNGI IN THE WINTER.—Mr. A. P. Morgan says, in the *Botanical Gazette*, that the winter season can not usually be considered very favorable to the growth of fungi, nevertheless, during warm and mild rainy spells many kinds will be found growing. Aside from the woody and leathery forms which are perennial or remain alive till spring, he has noted in the month of January some twenty-five or thirty species. Little or nothing is to be found coming up out of the ground, but on old trunks there are occasionally tufts, and about the roots or upon the erect, dead trunks of willows or sometimes of the sugar maple may be seen the yellow tufts of *agaricus velutipes.* An old dead tree in the woods is always a fertile subject. Look along it and underneath it. Pull off its bark, examine the inside and the wood next it. During the winter season clefts in the wood are also a fertile field for the studying of forms. Late in the Autumn and continuing through the Winter until Spring, colonies are to be found on the undersides of old, much decayed oak chunks, nestling in the holes and crevices in total darkness.

TO PREPARE LIGNITE.—Mr. F. H. Knowlton does this by macerating slices for a week in carbonate of potash to render them transparent. Thin sections are then cut with a razor, heated in a watch glass until they turn yellow, when they are to be dropped into cold water and afterward mounted in glycerine.

HOW TO DISTRIBUTE DIATOMS EVENLY on a cover glass is no small art. The Cole Studies recommend that the liquid containing the diatoms be dropped from a considerable height, and thus an even dispersion will be effected.



NEW PVBLICATIONS

THE MICROSCOPE AND MICROSCOPICAL METHODS, by Prof. Simon H. Gage. 8vo., pp. XIV, 96. Illustrated. Ithaca, N. Y.: Andrus & Church. Price, paper, $1.00; half leather, $1.25. The previous editions of Prof. Gage's book met with the commendation of every microscopist into whose hands it fell, although it was never regularly in the market, having been primarily prepared for the author's classes in Cornell University. This, the third, edition is prepared for the same purpose, yet it is, fortunately, not limited to that object, so that microscopists need not, as formerly, be under obligations to the author for a complimentary copy. At its low price, the book is within reach of every reader and of every worker with a microscope. If the owner of his first instrument will carefully read this pamphlet and will follow all the experiments described by the author, he will find that he has within his reach almost a royal road to the proper understanding of the microscope, of its manipulation and of the elementary preparation of objects, although the latter is exceedingly concise and somewhat meagre. The book contains much that is scattered through many books and magazines, and thus not within ready access of the amateur or the beginner. Its statements are correct and the result of much pains-taking research and study. Prof. Gage's description of the proper methods of using the Abbe camera lucida are the best that have come within my knowledge, and Mrs. Gage's original device for using the camera with the microscope in an inclined position without distortion of the drawing, will be a welcome suggestion to those that are less ingenious and less well informed in the optics of the apparatus. Her method of overcoming the trouble

that would otherwise make a circle under the lens appear as an ellipse when drawn on the paper, is simple and must be effective. The micro-spectroscope is also noted, and concise directions are given for its use, with several experiments. This is acceptable, as the instrument is not well understood by the rank and file of working microscopists, yet the apparatus is coming more and more into demand, and may soon be one of the most important of microscopical accessories. The chapter on the polariscope contains much matter not so readily accessible elsewhere, without much reading and the turning over of many books. The author is to be commended for his invariable use of the word "ocular," for the common term "eye-piece." It would be a benefit to all concerned if the word could be accepted by all writers and speakers on the subject, to the entire exclusion of the popular "eye-piece." Yet it seems somewhat of a blemish on an otherwise praiseworthy production, to find the author speaking of high and low oculars, invariably omitting to supply the indispensable word power after each. This is misleading and confusing, especially to beginners, be they pupils in Cornell University or beginners with themselves for instructors. Without some explanation, which is not given, the expressions high and low might be supposed to apply to the physical appearance of the oculars, which are high and low in height as well as in power, the high being low in power, and the low in height being high in power. Prof. Gage shows the same tendency in referring to objectives, often calling them high and low, with no additional word. With a living teacher to explain, these may not be so misleading as they certainly must be to the ignorant reader, with no help but this book. It would be much better and quite as easy to refer to oculars by the name of their equivalent focus. For "high" and "low" objectives there is absolutely no excuse. Twice on page 3, Prof. Gage refers to the objective as "microscopic," and to "microscopic" apparatus; on page 8 he calls the ocular "microscopic." Objectives, oculars and other microscopical apparatus vary greatly in size, it is true, but they are never microscopic; and lucky it is for those that use and handle them that they are not. The second page of the cover contains tables of metric and English measures of length, volume and weight, with rules for the changing of the Centigrade scale to that of Fahrenheit, all of which is acceptable.

A perusal of the book will polish up some of the advanced microscopist's half-forgotten knowledge and give the beginner something to think about and to practise, as well as to remember and to use every time he looks through his microscope.

THE ORIGIN OF LIFE AND SPECIES, AND THEIR DISTRIBUTION.—A new theory outlined by George Davis. Read at [*sic*] the Academy of Sciences, Minneapolis. Small 16mo., pp. 52. Price 15 cents. Minneapolis: C. D. Raymer. Indescribable trash and unmitigated twaddle.

EDITOR THE MICROSCOPE:—

I note in the abstract of the proceedings of the Washington meeting of the American Society of Microscopists, the name of the organization was changed to "The American Microscopical Society."

When the Society was originally organized in Indianapolis, at the close of the Microscopical Congress, the name was carefully considered and the name now adopted was rejected for the very good reason that it was the property of another organization, "The American Microscopical Society," of New York City, of which O. G. Mason, the photographer of Bellevue Hospital, and Dr. Atkinson, the well-known dentist, were prominent members.

As the old American Microscopical Society was not, so far as I can learn, incorporated, there is probably no legal question involved in the "appropriation" of its name by the national society, but there seems to be some question as to the ethical propriety of the action.

Yours very truly,

DUNKIRK, N. Y. GEO. E. BLACKHAM.

EDITOR THE MICROSCOPE :—

In view of the fact that you have shown so much interest in the subject as to print on pages 24-26 of the current volume of THE MICROSCOPE a somewhat extended account, with figures, of the new parasite of *Pinnularia*, described by Zopf as *Septocarpus corynophorus*, and hitherto known to occur only in Europe and at considerable altitudes, it may interest you and some of your readers to know that I have found this parasite on a *Pinnularia* (apparently *P. viridis*) among the grass of an overflowed meadow in Belchertown, Mass., at an altitude of between 300 and 400 feet above the sea. It is, therefore, to be expected that it may be found quite widely distributed, and, perhaps, common. These aquatic parasites of the family *chytridiaceæ* have received almost no attention in America, and I shall be very glad if your readers would send me specimens, living if possible, of any parasites of algæ or aquatic fungi with which they may meet. Any assistance in my study of the American forms of this group will be much appreciated, and will be suitably acknowledged in connection with the publication of results.

Very sincerely,

AMHERST, Mass. JAS. ELLIS HUMPHREY.

EDITOR THE MICROSCOPE :—

A short time ago I had the privilege of spending an afternoon with Messrs. Spencer & Smith in their workshop, at 250 Allen street, Buffalo, N. Y., and watching the process of making objectives for the microscope.

I was well acquainted with the elder Spencer, the famous Charles A., who many years ago turned out the wonderful objectives from his little shop in, at that time, the backwoods village of Canastota, N. Y., with which Prof. Bailey, of West Point, aroused the wonder and incredulity of his European correspondents. But it was many years since I had met the son, Herbert R., who is proving a worthy successor to his renowned father, and I, therefore, eagerly accepted an invitation to spend an afternoon with him in his den.

The first thing that struck me, after the cordiality of my welcome, was the modesty of the men and the simplicity of the apparatus with which they have achieved their wonderful results.

I found myself in a second story front room, about sixteen feet square, furnished with three foot-power lathes, a plain pine table, a couple of cupboards, a couple of stools, a couple of chairs, and—nothing more. The magic evidently was in the fingers, not in the machinery.

Among the relics of the elder Spencer, the son showed me a box containing bits of spar selected to make lenses of, and one old lens, constructed more than thirty years ago, in which the spar has become laminated and cracked, rendering the lens useless. It was on account of this tendency of spar to deteriorate that Mr. Spencer abandoned its use for lenses in his objectives, to have it taken up again, and hailed as the very latest advance in scientific microscope making, long after he was in his grave.

I also saw the little lathe on which much of his work was done, a rough looking little affair made by his own hands in a Canastota blacksmith shop.

After looking over these and some other relics of the old times and watching the deft fingers of Herbert and his partner shaping the bits of glass that were to form portions of sundry new lenses, we came down to the real business of the afternoon, the critical examination of some of their latest work.

The first thing was one of the new formula dry $\frac{1}{8}$, aperture 150° air (about 0.95 N. A.) This was screwed on to the old stand, evidently a veteran, and a slide of *Podura* scale slipped on the stage. The illumination was from the edge of the flame of a common flat-wicked kerosene lamp and the concave mirror. No Abbe condenser to bedevil the light with its excessive spherical and chromatic "abbe" ration. But there was no lack of light even when the $\frac{1}{4}$ inch ocular was used, and what sharpness of definition and limpid colorlessness of field! With the same lens and various oculars, the balsam mounted Moller Probe-Platte was attacked with oblique illumination, still from the lamp and mirror only, and still with ample light and a field almost as free from color as with a central light. No. 18 yielded easily and, by careful manipulation, the striæ on No. 19 could be seen. And just here the superb qualities of the new eye-pieces were demonstrated. Objectives which had done well with the lower power eye-pieces of the Huyghenian type did better with the $\frac{1}{2}$ and $\frac{1}{4}$-inch eye-pieces of the new formula, the chief improvement being in the more perfect correction for

color and the exquisite definition of the marginal as well as the central portions of the field. I have been promised a loan of one of these new eye-pieces, to try with my own objectives, and if it shall prove to work as well with objectives of other makes as with those of Spencer & Smith, I shall regard it as a real advance in microscope construction.

Incidentally, the subject of telescope construction came up, and I was shown one—the new short-focus telescopes, the clear aperture of which is 7-10 of an inch, and the total length over all, when opened out for use, is only $6\frac{1}{4}$ inches. It is easily carried in the vest pocket, occupying a space of only four inches in length by less than one inch in diameter, when closed. It bears an eye-piece amplification of fifteen diameters, and with this power gives a large field, with excellent definition and ample light.

I was sorry that Mr. Spencer had no samples of his highest grade of homogeneous immersion objectives to show me, but perhaps I had seen enough for one day, and I took leave of the skillful young optician, well pleased with the man, his work, and the simplicity of the mechanical means with which it was produced. It would be a revelation to workers who believe in the necessity for sub-stage condensers of large aperture, carefully centered and focused, to see the ease and certainty with which the finest results were brought out with lamp and mirror, only when manipulated with the proper knowledge and skill.

The whole afternoon was entertaining, instructive and altogether delightful to me, and I have thought best to give your readers such share in my pleasure as they can glean from my poor account of it.

DUNKIRK, N. Y. GEO. E. BLACKHAM.

From microscopical preparations, Heller estimates the number of tubercle bacilli in the sputum of a tubercular subject at 1,000,000 per cubic centimeter; in a single expectoration, on an average, 3,000,000 bacilli are discharged.—*Wiener Med. Woch.*

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